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SCIENCE

for the

ELEMENTARY SCHOOL

NORTH CAROLINA PUBLIC SCHOOLS

PUBLICATION NO. 293

SCIENCE

for

The Elementary School

STATE SUPERINTENDENT OF PUBLIC INSTRUCTION
RALEIGH, NORTH CAROLINA

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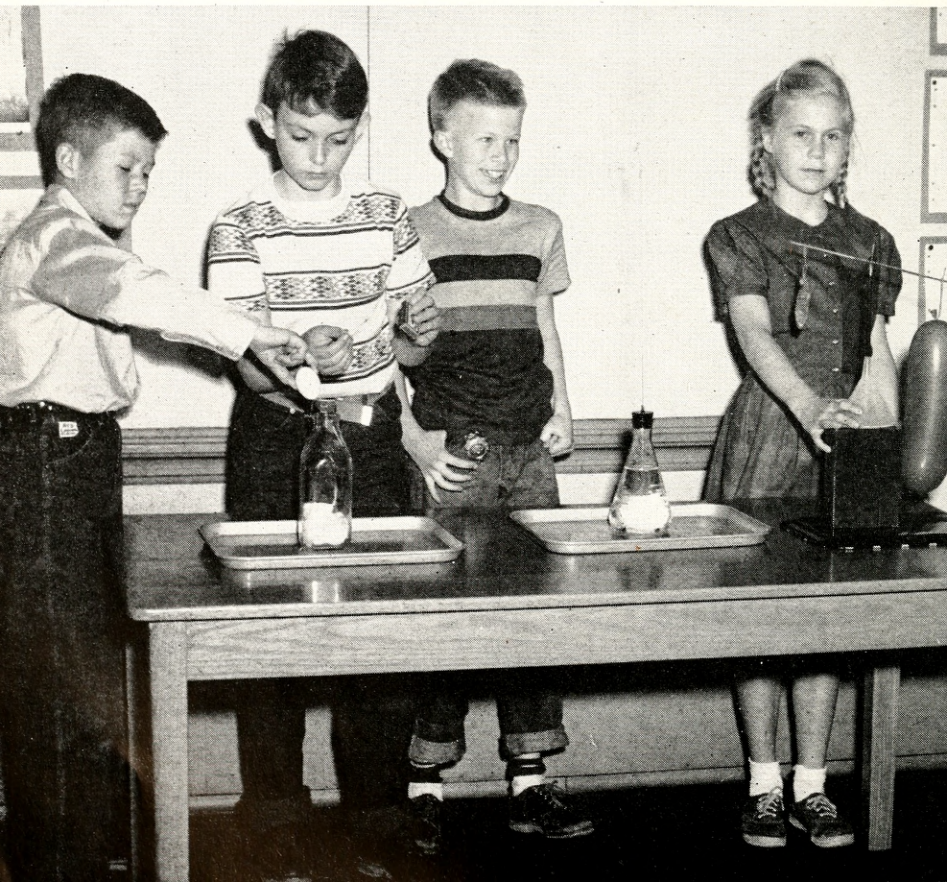

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FOREWORD

Our first separate publication for science, *Science for the Elementary School,* issued in 1941, was very widely used. The supply of that publication is now exhausted. This new science publication is not a revision of the former publication; it is written from an entirely new and fresh point of view. Here, method and content are skillfully and interestingly woven together by simple language, examples and illustrations.

Perhaps in no other area of the curriculum is there more opportunity to demonstrate and create so many genuinely purposeful activities as in science. This publication contains many science facts and many suggestions for scientific teaching. Teachers will find these ideas stimulating as they plan with children to build and establish science concepts in a scientific way of learning.

Prepared by Miss Julia Wetherington of the Division of Instructional Service, this publication brings together the cooperative thinking of a number of teachers and supervisors in North Carolina.

It is with a great deal of enthusiasm that I have authorized the printing of this curriculum guide for the teachers of the State. It is hoped that it will give further impetus to the progress which we are already realizing in the teaching of science in our elementary schools.

Chas. F. Carroll

State Superintendent of Public Instruction.

July 1, 1953

Let Us Get Science "Out Of The Corner" Into The Lives Of Boys And Girls.

ACKNOWLEDGMENTS

This bulletin has been in process for some time; not in actual assembling, but from the ideas and practices that individual teachers, principals and supervisors have given in interpreting science instruction and the functions of science in the schools. To all of these persons, and for the ideas, there is deep appreciation.

Grateful appreciation is expressed to the following State Planning Committee chairmen who assisted through co-operative planning, contributions, personal time, and group work in their county or city unit:

Mary K. Logan	Supervisor, Moore County, Carthage
Ruth Robinson	Supervisor, Mecklenburg County, Charlotte
Margretta Seagle	Supervisor, Lincoln County, Lincolnton
Mrs. Edith P. Ball	Teacher, Scotland Neck
Bessie Massengill	Supervisor, Harnett County, Lillington
Cora Lancaster Marks	Supervisor, Beaufort County, Washington
Barbara L. Baucom	Teacher, Sherwood-Bates, Raleigh
Mrs. Cleo Griggs Horne	Supervisor, Unoin County, Monroe
Hazel Copeland	Teacher, Woodland, George
Mrs. Mattie G. Hickman	Teacher, McIver, Sanford
James H. Dunlap	Supervisor, Wilson City, Wilson
Mrs. Rosa Judson Tillett	Supervisor, Durham City, Durham
Mrs. Ruth L. Woodson	State Supervisor, Negro Public Schools
Co-Chairmen in Library Materials	
Mrs. Mary P. Douglas	Supervisor of Libraries, Raleigh Public Schools
Cora P. Bomar	State Library Adviser, State Department of Public Instruction
Co-Chairmen in Audio-Visual Materials	
Estelle McClees	Supervisor of Science and Audio-Visual, Burlington
Dale F. Keller	Supervisor of Audio-Visual Material, Greensboro

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Mrs. Beulah T. McPherson Carthage

The *examples* used in this bulletin to "point up" ideas and to illustrate subjects are from the schools below:

Vance	Asheville	North Elementary	Winston-Salem
Vanceboro	Craven	North Belmont	Gaston
James A. Whitted	Durham	Celeste Henkel	Iredell
West Lumberton	Robeson	White Oak School	Chowan
Bakersville	Mitchell	Bath School	Beaufort
North Main	Mt. Airy	Parkton	Robeson
Dobson	Surry	McIver	Sanford
Graham	Alamance	Dunn	Harnett
Kiser	Rowan	Epworth	Craven
Carver School	Forsyth	South Main	Mt. Airy
J. W. Seabrook	Cumberland	Eugene Rankin	Asheville

Draper	Leaksville	Lockhart	Wake
Scotland Neck	Halifax	Pinetown	Beaufort
Belhaven	Beaufort	John Small	Washington
Mocksville	Davie	Bridgeton	Craven
George Watts	Durham	Rowland	Robeson
Erwin	Harnett	Reeds	Davidson
Leaksville Graded	Leaksville	LaFayette	Harnett
North Spray	Leaksville	Perquimans-Training	Perquimans
Apex Junior High	Wake	Dunn	Harnett
Oxford Graded	Oxford	Armstrong	Cumberland
Scott's	Iredell	Altamahaw-Ossipee	Alamance
Oak Hill	High Point	Forest Park	Winston-Salem
Wallburg	Davidson	City Unit, A	Cherryville
Boone Elementary	Watauga	County Unit, A	Mitchell
Hilly Branch	Robeson	School Faculty, A	Mt. Street, Ashe

The pictures in this bulletin are from the following schools:

Central	Kings Mountain	Boone Elementary	Watauga
Lyon Park	Durham	Flat Rock	Surry
George Watts	Durham	Currituck	Currituck
Burlington	Burlington	East Lumberton	Robeson
Vance	Asheville	Celeste Henkel	Iredell
Ardmore	Winston-Salem	North Elementary	Winston-Salem
Carver Consolidated	Forsyth	Sherwood-Bates	Raleigh
Bakersville	Mitchell	Parkton	Robeson
Ray Street	High Point	McIver	Sanford
Pinehurst Elementary	Pinehurst	Wallburg	Davidson
West Lumberton	Robeson	Lockhart	Wake
Celeste Henkel	Iredell	Eugene Rankin	Asheville
Draper	Leaksville	Mocksville	Davie
J. W. Seabrook	Cumberland	Erwin	Harnett
Belhaven High School	Beaufort	Reeds	Davidson
Leaksville Schools	Leaksville	Churchland	Davidson
Oxford Graded	Oxford	Draper Graded	Leaksville
Scotts	Iredell	Armstrong	Cumberland
Dunbar	Davidson	Du Bois	Wake

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JULIA WETHERINGTON
Associate, Division of Instructional Service.

July, 1953.

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PURPOSES

The State Committee and contributing consultants to this bulletin, SCIENCE FOR THE ELEMENTARY SCHOOL, worked out certain understandings as to what the bulletin would attempt to do. The statements, beliefs, program, activities and references are an extension of those understandings.

Elementary science is a regular part of the child's curriculum in the North Carolina public schools. Therefore, this bulletin is intended to stimulate more good science teaching. It is not a complete course of study.

The bulletin points to:

—some beliefs about the child.
—some values in science instruction.
—some ways of living and working together.
—some areas for study by years.
—some ways of purposeful doing.
—some sources that would seem to make the child's program in science a better one for him.
—some essential understandings.

The Child.

The child grows as a "self" as he grows in science. He is an organism and reacts to every thing as an individual and as a member of a group. His science information, his feelings, attitudes and behavior patterns develop together. The child is as important as his science content.

Some Values In Instruction.

The selection of pertinent problems.
Effective ways of solving problems.
Content, facts and behavior.
The development of scientific attitudes.
The use of science principles, meanings or generalizations in our daily living.
Sincere experimentation.
Regard for nature on and beyond the earth.
Respect for authoritative source material.

Ways of Working and Living.

The classroom is a laboratory to use ideas and materials to solve problems. Children and teachers plan together. The teacher

is a member of the group. Children work on a problem by groups. These groups share their findings to the total groups.

Areas For Study.

The teacher is the only one in the classroom group who has an overview of the child's science program, grades one through eight. The child sees the immediate segment. The teacher has to "open up" new areas or problems for study to insure sequence of learnings. *She has to see that every topic studied moves the children upward.* If children progress in all suggested areas from year to year there will be little time for repetition.

Ways of Purposeful Doing as Aids to Learning.

The fourteen ways of purposeful doings (see p. 15.) are based upon the following beliefs:

1. Children learn through a variety of activities.
2. Children become competent in an activity, such as problem solving, by direct training.
3. Children need skillful help from the teacher to become skillful themselves in discussion, observation, field trips and other activities.
4. Ways of doing are less important than how the child feels about it and "takes hold of" his task.
5. Activities are a means to developing more useful, democratic citizens.

The State Text and Other Material.

The State has an adopted science textbook for grades I-VIII. Each text has a manual or guide. The manuals give specific helps to the teacher on each unit of work. Therefore, it is not the purpose of this bulletin to try to duplicate the manual material.

In addition to the State adopted text and manual guides, which are functional, there are:

—Series and individual texts in the State approved supplementary listing.

—Over 100 books of Science content listed in the 500-599 State supplementary list of library titles. There are numerous books that give facts about animal life, plant life, the earth, the universe, chemical changes, physical changes, science inventions, and other subjects listed in the library titles.

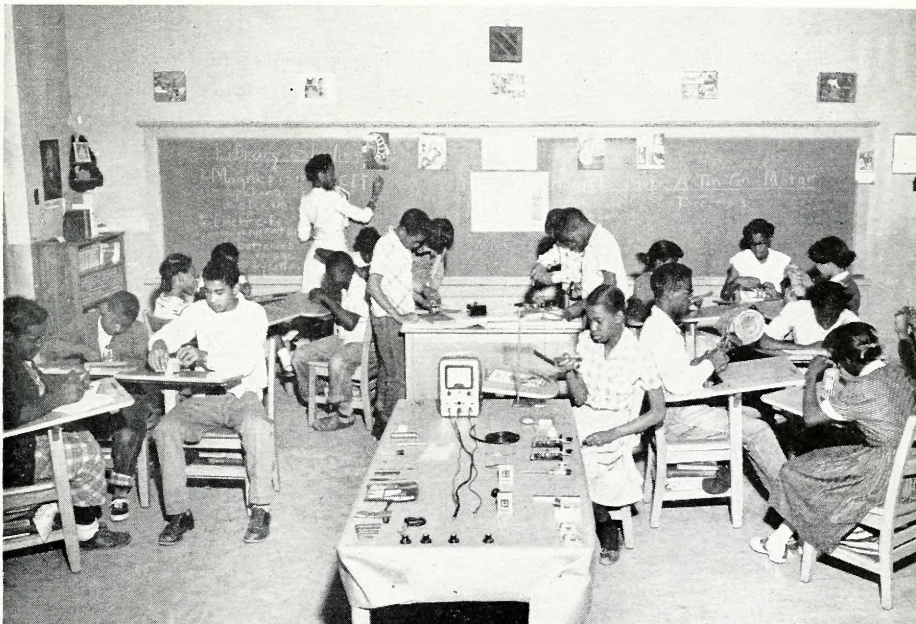
—Numerous pamphlets for evaluation and use on various subjects, as: Wildlife, natural resources, forests, textiles, synthetics, conservation, and electricity.

—Possibilities in the great out-of-doors as a laboratory of visual aids—visual aids in flats, specimens, and well selected films and filmstrips, and recordings.

Reference.

Cunningham and others. **Group Behavior of Boys and Girls.** 1951. Teachers College, New York.

Children work on a problem by groups



THE CLASSROOM TEACHER TEACHES SCIENCE

Good methods of instruction that apply in other subjects will apply in science with, perhaps, additional experiments and field trips. Yet, some teachers express a feeling of extreme insecurity in Science teaching. But elementary science specialists give encouragement to anyone who is fearful. One says, "The teacher need not be a science specialist any more than he needs to be a specialist in mathematics to teach that in the grades. Teachers need have no hesitation in saying, 'I do not know,' whenever that is true. They need however to add the spirit of being interested in finding out." [1]

Another scientist gives encouragement to the teacher when he says:

"1. Science in the elementary school should be kept very simple.
"2. You can learn with children.
"3. Science experiences often work in naturally with the general learning going on in your room." [2]

> Fear tension is released when the teacher and children plan and explore together.

The Classroom Climate

The very nature of the classroom organization where the children and teacher talk together of everyday happenings makes it easy for science experiences to become a part of the child's school life. It should. Gardening at home, a trip to the planetarium, father's work in the mica or feldspar mine, fin-fish and shellfish as a food, seed testing, or a new baby calf are examples of the interests of children that "burst out" in school. These happenings can end in mere events. Or they can end in interpretations of better ways of living, such as seed improvement, uses of minerals, conservation, or life comes from life. The ways they are developed and the way they end depends upon the teaching. Children's interests are about the same everywhere.

> A few children will get the science interpretation alone, but for the majority the science concept has to be taught.

It is often more difficult for teachers to delve into a new science topic than for children. Children seldom show fear of it even if they attempt concepts far beyond them. Often, too, a child knows more about a particular subject than the teacher. The teacher need not let that upset his feelings. That does not mean that the child's general information exceeds his. The child has simply learned more facts about *one* thing—be it airplanes or electricity. *But the information of one child should not set the desirable standard for the group.* Children differ. From one child's special accomplishment the teacher and group can select those things that seem to have the most in social significance for the members of the group and use them.

THERE ARE MANY WAYS BY WHICH A TEACHER CAN FEEL MORE SECURE IN SCIENCE TEACHING:

1. Read science textbooks written for children in grades I-VIII. There are interesting facts in them, simply told. If you teach grade 4, be sure to read the texts for grades 3, 4, and 5.

Fear tension is released when the teacher and children plan and explore together

2. Read some of the library books in the Science category.
3. Know the "beliefs" in the manual or teacher's guide. Use the manual.
4. Try out the experimental activities first "all by yourself." It is fun.
5. Know something of the home life experiences of the child, as you can.
6. Take additional courses in science for the elementary school.
7. Find out what the authors of two or three professional texts think on science in the elementary school.
8. Plan one or join a teachers in-service workshop.
9. Keep alert for current literature.
10. Make field trips with other teachers, or alone.
11. Add pictures and articles to the school library. Use them.
12. Preview many films and filmstrips on the same subject.
13. Join the National Science Teachers' Association, N. E. A., if you wish.
14. Alert yourself to the use of scientific attitudes.

References.

1. Craig, Gerald S. *Science for the Elementary School Teacher.* Ginn and Co., N. Y. 1947.
2. Blough and Huggett. *Methods and Activities in Elementary School Science.* Dryden Press, N. Y., 1951. p. 4.
3. Blough and Huggett. Ibid.

THE TEACHER AND VALUES

The teacher's leadership in science instruction comes mainly from his values. Values are very important.

Children are interested in the great mass of plant life, animal life, in physical conditions, in things on the earth and conditions beyond the earth. Content is plentiful. In terms of facts one could learn, there is no end to it.

> Out of the mass of possibilities, it is the teacher's values that determine if the child's time will be well spent.

The problem is: What seems to be the most important, at a given time, how much shall be attempted, what can be left out? A "whittling off" process sometimes helps. Are our values based upon how much we can teach or on how meaningful the study can be to the child?

Shall much time be given to study of single objects, animals or plant life, to identifications?

Are the child's reactions from his science learnings the center of our values?

Do we watch as carefully for the use of scientific attitudes as we do for the knowledge of facts?

The selection of problems will be broad enough not to confine the child to one insect or to one animal. The child should see life—animals, insects, plants, humans, in relationship one to another.

If worthwhile values are operating, the problem will apply to the child's life.

Teaching Scientific Values

With guidance, children in the elementary school can come to know and use scientific ways. In science instruction children can:

1. *Develop scientific attitudes,* a spirit of open mindedness, of further inquiry, of cause and effect relationships.
2. *Have training in critical thinking.*

> Science is more than the knowledge of facts; Science is also a way of thinking and of doing to find answers to problems.

If that is what we want, if it is a worthy objective, the teacher's leadership must plan for it. The teacher has to "open up" some subjects. It is more logical for the teacher and the children if the teacher uses those elements of scientific attitudes that she wants the children to have. How often do the children hear the teacher say, "Perhaps, that is so, I do not know."—"I thought so, too, once, it was an old superstition I had." "Let us work together, I want to know more about that." "I cannot say yes, because I am not sure." Too, the atmosphere of the classroom must be conducive to an easy flow of ideas between children and between children and teacher. We can use scientific attitudes in solving big and little problems.

> It is as possible to plan for the children's use of the spirit of open-mindedness, of inquiry, of looking for proof and acceptance as it is to plan to see an experimental proof of osmosis. The osmosis experiment is faster. The intangible is more difficult to see.

Teaching Scientific Attitudes

"It must be realized, therefore, that (1) scientific attitudes and elements of scientific method are *tangibles*, and (2) specific efforts must be made in instructional procedures to teach them.

"What, then, are the scientific attitudes and elements of scientific method?

"*The Scientific Attitude*—The ability and intent to think clearly and logically. These include:

1. A curiosity about the world in which we live.
2. A belief that every happening has a cause.
3. A refusal to accept statements as facts unless there is sufficient proof.
4. A desire to observe carefully.
5. A refusal to draw conclusions until enough evidence is available.
6. A respect for the opinions of others and a willingness to change our opinions in light of new facts." [1]

When the teacher and children work together "to find out how and why things happen," as soil erosion in the yard, or to produce a situation for a purpose, as to produce mold on bread, the scientific attitude is at work.

—they plan.
—they search for facts.
—they try out.
—they check what they find and see.
—they apply these facts to their own uses.
—they draw some conclusions.

How far they go into either of these depends upon the subject and upon the teacher's values of its worthwhileness.

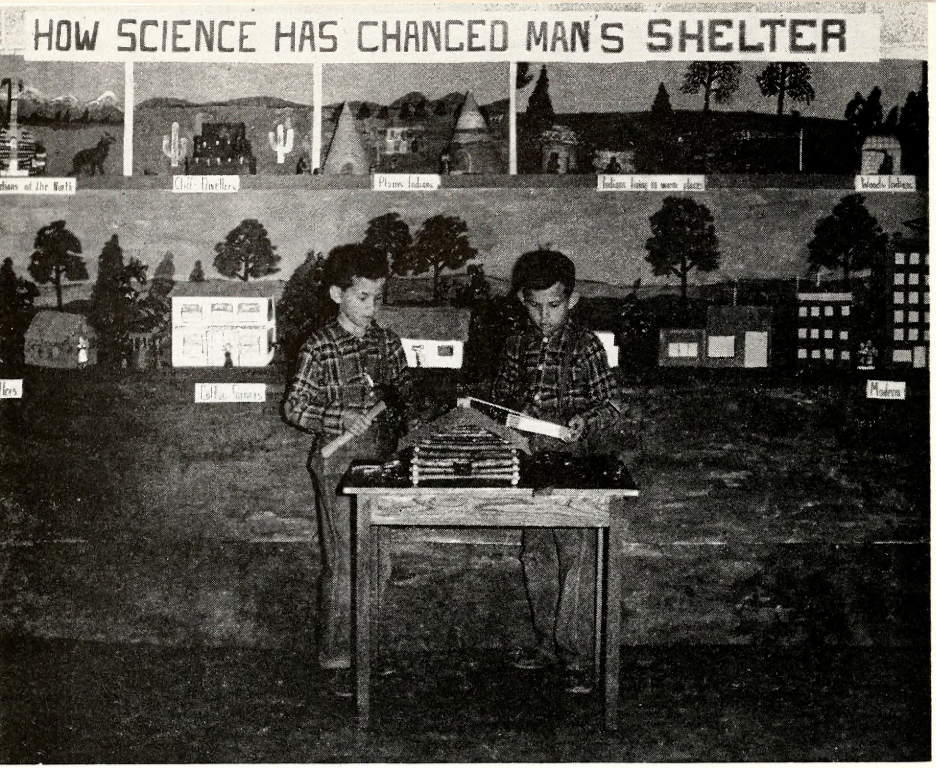
Haste *Neither of these can be done in a hurry.* Haste is not in keeping with the scientific method. It takes time for the children to:

—plan co-operatively.
—search in books and elsewhere for facts.
—talk over the applications in their experiences.
—think.
—evaluate.

> One objective of the scientific method is to help each child act upon information.

Critical thinking—Often the child does not show promising critical thinking attitudes because he does not know what it is. He has heard the teacher say many times, "Now you must think," or "Now think hard." To "think hard" to him may be to try to recall a fact. In critical thinking he does recall. But he weighs facts and draws conclusions. It may not have occurred to him that he is using a critical thinking approach, for example, when he is doing these things:

1. looks for more facts.
2. reorganizes the facts that he has.
3. withholds judgement.
4. does not rely upon guessing.
5. rejects superstitions.
6. comes to know the difference in facts and opinions.
7. accepts more than one way of approaching a problem.
8. questions his own ideas.
9. discounts varieties of fortune telling.
10. discredits magic as science.
11. being aware that there is more to learn later on the subject.



How science has changed man's shelter

Scientists tell us that we need to look to what science can do to improve our way of life. One scientist says:

—"Science makes it increasingly possible to improve the health and safety of the people of the world.

—Science makes it possible for us to eliminate backbreaking toil.

—Science makes it possible for hunger to be abolished.

—Science makes it possible to abolish poverty." [2]

And another scientist says, "We do need persons who are well informed about the world in which we live—But let us not consider a person educated scientifically just because he can tell us how many legs a cricket has, knows that a pair of pliers is an example of a first-class lever, recognizes a tufted titmouse when he sees one or can define chemical change."—"We say, then, that the study of science should help boys and girls come to know some generalization, or big meanings or science principles which they can use in solving problems in their environment." [3]

And we think now that knowledge of our environment and of the relationships of one object or force upon another is important.

> All human life, all life, and all things are a part of the changes in our civilization.

We need to look to those values that help the child to see and understand:

—our past from the beginning
—our present life as an era in a span of time and change
—our unforeseeable future through the best uses of science

Interpretation Craig says, we are reminded that there are science conceptions which help us in interpretations; they apply to the rural environment as well as the urban; they are not limited in significance to one state or one nation; they are universal in character. These conceptions may be utilized to interpret children's experiences with natural phenomena.

These with one illustration are: [4]

SPACE. Space is vast.

TIME. The earth is very old as measured in terms of our units of time.

CHANGE. The surface of the earth has not always had its present appearance and is constantly changing.

VARIETY. All life comes from life and produces its own kind of organism.

ADAPTATION. Species have survived because by adaptation and adjustment they have tended to become better fitted to the conditions under which they live.

INTER-RELATIONSHIPS. Light is indispensible to life.

> Real science teaching is taking place when there is interpretation in terms of these universal principles.

Science instruction should help to discriminate between that which is

valuable	—	not valuable
true	—	untrue
pertinent	—	not pertinent
helpful to mankind	—	not helpful to mankind

In content, place and time values the teacher must know what is good instruction for the child. He is the *only* person in the classroom group who has an overview of the child's curriculum

in science. He is supposed "to guide" the studies to insure sequence of learning.

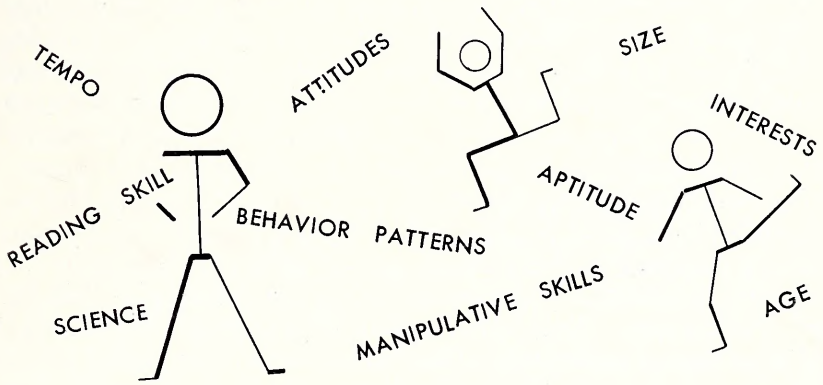
> The teacher must know that he is working for principles and generalizations.

References.

1. National Science Teachers Asso., *"Teaching Scientific Attitudes."* NEA 1201-16th St., Washington. Sept. 1952.
2. Craig and Baldwin. *Teachers' Manual for Science Every Day,* Ginn and Co., Boston. 1946. p. 2.
3. Blough and Huggett, *Methods and Activities in Elementary-School Science.* Dryden Press, N. Y. 1951. p.13.
4. Gerald S. Craig, *Science for the Elementary School Teacher.* Ginn and Co., N. Y., 1947. pp. 11 and 12.

A LOOK AT THE CHILD AND HIS SCIENCE

Children differ in any group. The teacher uses these differences.



Individuals differ. And boys and girls differ somewhat. These differences do not "come out" just in science instruction. The same boys and girls working in language arts or in social studies are the same boys and girls as when they work in science. The differences listed here are only a few of the ways in which these differences occur.

> The teacher comes to know differences and uses them in the child's growth and development.

A General Program

How then can we look at these differences, as a help to the child and to members of the group, in a proposed program for grades I-VIII?

We look for the child's total development and sequence in learnings. Mainly, the science work in the elementary school is simple enough to be within the general understanding of the members of the group. It should be. The usual class group has some advanced and some slow moving members. They make contributions to the group and for themselves according to their ability and interests. That is encouraged. The particularly gifted child is expected to have enrichment materials and projects. *But again, let us watch ourselves that we do not let the advanced child absorb the time and set the standards for the entire group.* And the slower moving child will be a more secure

member of the group if his expectancy is geared to his power. He needs materials on *his* level. He needs to feel that his contributions are needed, too.

Interests of Child and Teacher

Usually the child is interested in the subject about which he knows something. One in a group, through association, might know a great deal about "forestry." His father is a forester. Another one knows about electricity for the same reason. This child would lead the group each year into his own interests. That would be folly for the class. It would be wise to use the information any child has that seems to have social significance for the members of the group and move on to another topic.

Children's interests in science do not run in categories or by sex preferences. Girls will develop interests with machinery when given an opportunity. Children's interests are often spontaneous, of short duration; it may be on one subject, over and over. Their interests are particularly flexible at certain ages.

> It is well to use the interests of children but a science program cannot depend upon it. It will be too "hit-or-miss."

Interests do not happen, just at seasons. If we follow that type of subject selection, each grade in the school will be studying certain animals and insects at certain seasons every year and on about the same level from year to year. Interests should determine the study when that subject is more important for the group, relatively speaking, than any other topic that they could study. Children's interests are largely stimulated by the teacher's interests. So the teacher must be very cautious not to "ride a hobby," such as shells.

> So called following the lead of children is too often following the lead of *one* child out of 30. [1]

Tempo

Pressure and haste are not in keeping with the rhythm and tempo of child life. Through better organization, practice, and the "know how" of things, one increases his speed. Science may produce speed. But science is

concerned with finding the truth in a scientific way. Speed is relatively unimportant for children in science study.

Age and Size

Children grow up and develop at different rates; most often girls mature faster.[2] In preadolescence there is a "resting period," followed by a period of rapid growth in height and then growth in weight; this usually starts somewhere between 9 and 13; boys may mature as much as two years later than girls.[3]

> The different growth stages of children are significant in Science instruction as in other subjects of the curriculum. For with these, the child has associated characteristic reactions and special needs.

Behavior Patterns

During this period, while a child's personality is becoming increasingly complex, it becomes more of a challenge to understand him. His growing independence and ability to think and reason for himself are sometimes disconcerting. It upsets our notions of our superiority just a bit when our children begin to question our opinions, and to have very definite ideas of their own.[4]

> While he grows in Science, he grows as an individual; he is developing a "self."

That is a fact that we, as teachers, must ever keep in mind. The child, and what his science does for him, is our first consideration.

The reactions of children to the things about them and beyond them—things they like to do, and their ways of doing them are useful in science instruction. Some of them are "teachable moments" for them. The child's ways of reacting to things can be used in problem solving. *His behavior tendencies can be used.*

At times he seems eager to:
—try out everything about him.
—sit watching adults work with machinery.
—follow the older brothers in field or stream.
—follow the fire engine.
—get under the foot of the plumber.
—try guessing games, riddles and conundrums.

—dramatize in costume.
—taste plants, seeds and medicines.
—take apart his bicycle.
—collect objects of any description.
—search for pictures or facts in books for a little while.
—do excessive play.
—watch living animals and insects.
—build and rebuild.
—skip his bath.
—plan for, collect, and work in—as a garden.
—put simple machinery to work.

> A child's behavior tendencies do not always come and go at certain ages; but they are reasonably within certain years. Some persist longer; some do not occur. An aware teacher expects them.

Attitudes

The child begins to develop attitudes when he is very young. The child's love for his mother, his family, and later for his own family life is an example of an attitude that began in infancy.

The school can begin to help the child in scientific attitudes from his first year in school. It can help him in the ways he finds facts and how he uses them. It can help him in his respect for the truth. Step by step he is encouraged to make close observations, to tell what he has seen or done, to check these, to be sure that his opinion is not "snap judgement."

> Scientific attitudes will not be secured by the mere teaching of science units. [5]

In a classroom where children were growing in critical thinking, one heard children saying: "This book says . . . . . "; "John's report said . . . . . "; "our committee observed . . . . . "; "after watching the . . . . . longer, we changed our report." "We used . . . . references. We are not quite ready to make a report, we have other . . . . . to see." And a child in a third grade was heard to say, "This book has a later copyright."

If we are to train children to look for truth and have respect for it, we must also help him to distrust and question such things

as: superstitions, guessing, hear-says, prejudices, undue emotion, opinions without facts, and mass thinking.

In science, as in other areas, the child's attitudes vary. He needs help in crediting scientists and the results of their study and labor. The scientist is not a queer person; things do not just happen. To grow in respect for science studies, research, experiments (experiences) and fact-finding techniques are a part of science instruction.

Reading Skills

Within a classroom group there will be a wide range in the reading abilities of the children, even though they have had similar amounts and types of reading instruction. These differences will be evident, perhaps even more so, in reading in special subjects, such as science. The individual child's differences can be taken care of by the different types of activities he performs, including reading, as he shares in problem solving. [6]

Science calls for a study type of reading. The way it is used makes it a slower process, unless the material is easy for him. He may also be doing a different type of thinking. He has to use his material to become acquainted with new facts, to organize these facts, and to draw conclusions. Children need to know what that recreatory reading and science reading usually require a different approach.

Russell says children encounter three main problems in reading any type of specific content—history, science or arithmetic.
(1) the technical vocabulary.
(2) the different types of organization or patterns of thought.
(3) specialized devices for conveying ideas, as thermometers. [7]

We should begin in the first grade to help the child feel "at home" with the terms of science as he reads and talks about the things in his environment. However, to learn the terms for the parts of a flower, an insect, or the bones in the body are useless memory exercises.

Science like other subjects has a vocabulary of its own that must be used. Such words as osmosis, electrons, evaporates, magnetic field, barometer and chlorophyll are challenging. Often the child likes to try the "new long word."

> Word study is best when developed in discussion or problem solving.

It is important to recognize the many differences in the understandings we expect of the child and in the materials we, as teachers, expect him to use. Whatever his level, he interprets with the meanings he gets. We expect the child at any level to gain as much as he can from a topic, but not to learn all there is to know about the topic. Again, later, he will be able to read and work on a higher level.

> As children discuss a topic, perform an experiment, or relate their findings, it is most important that they use the terms of science correctly.

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THE CHILD AND HIS QUESTIONS

The very young child continually asks questions that show his curiosity in the things about him and in the sky. Ellen Walpole says,—"His desire to know springs from two sources—a genuine curiosity in things for their own sake and an emotional need to feel his own place in the unfolding universe around him." [1] He comes to school with that same inquisitiveness.

> The teacher who studies the child's questions, how to organize and use them finds that they have a *real* place in the elementary school science study. More interests can be stimulated through them.

Even the young child can begin to sense an "appropriate" time for his question. He is often impatient and wants to know "right now" and asks irrelevant questions. Many times an older child does not recognize if his questions are a part of the subject being discussed.

A seventh grade teacher was teaching a well planned lesson in History, with apparent interest and participation from the group. Suddenly a hand arose. "Can you tell me which corn has more vitamins in it—white or yellow? I have wanted to know for a long time." How to handle that type of question and to protect the child and the other children is a problem. For the child, at any age, knows when the teacher:

—shows respect for his question.

—gives him help in ways to find out.

—encourages his curiosity.

—does not always expect a ready "yes" or "no."

—seems willing to help him.

—gives him time to think and talk.

—shows consideration for the other members of the class, too.

> The teacher's attitude towards the child's question is as important as the information she gives him.

Often the child's questions come from a spontaneous interest, such as "Do plants have blood?", another question may extend beyond the earth, "Do plants grow on Mars?" Again, the question is based on a superstition or untruth, as "Why do ostriches bury their heads in the sand? Why will black snakes run you?"

Even though the questions may seem preposterous, it is very important that we do not make the child feel ashamed of them. Do not laugh at him or let others do so. If the question seems beyond science discovery and invention at the time, we cannot wholly discount it for the future. The possibilities of the future in science are not known.

> The child's questions are valuable but a sequence of learnings cannot depend upon them entirely.

Teacher Guidance

Some topics start from the teacher. Some start from happenings at home. Some start from books. Some from the radio or television. Some from children's questions. Whatever the source of a study, the teacher has to have an overview of the child's general program from grades one through eight and to know the value of the study in relation to time.

A developmental program in Science does not just happen without teacher guidance. Children, like adults, look to their past ways of doing, to their past topics of study. They studied insects last year; they would like it again this year.

> Children will repeat over and over. It requires a keen overview to use the child's questions and to guide group study into new information and expand old topics.

The child does not attempt to learn all about a subject in one topic nor in one year. Each year he adds to his information, not

by exactly repeating but by enlarging and extending his information on a topic.

When To Use Children's Questions:

How to use the questions wisely concerns every conscientious teacher. Often the teacher needs to propose that the child's question would be left to another time when more study can be given to it. They make note of it so that they would be sure not to forget it. Immediate use of the questions depends upon the nature of the question and time required to help answer it. There will be "little topics" or questions to solve. There will be "big topics" or questions that require more time and an extended amount of work. A "big topic" will have many "little topics" within it. *The teacher plans with the children to find answers that will satisfy them at each stage of their growth level.*

> A program that depends for direction on the incidental questions of a child loses some of the accumulative richness found in well planned experiences.

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SUGGESTED TOPICS BY GRADES

Subjects in *Science* for Problem Solving	First Year	Second Year
Animals	Family life. Protection and care, food and sanitation. Animals eat plants.	Animal changes in seasons. Animals differ in food, homes, habits, appearance. Animals resemble their parents. Water animals in our ponds. Insects in our homes and gardens.
Plants	Seeds start new plants What plants need to live. Things alive.	Plants that live in winter; that do not. Our garden plants—fall, winter, spring, summer. People need plants and animals.
Weather	Observing seasonal changes about us. Changing our play. We get ready for weather changes.	Recording the signs of changes in the seasons. Preparing for seasons.
Magnets	Some things magnets will do.	The earth pulls thing to it. The earth moves all the time.
Electricity, Energy, Power, Change, Force	Making things go by levers. Water. Wind.	Making things work by electricity, steam, horses, tractors, air.
Homes	All animals need a safe home. Animal homes. Birds' homes. Man's home.	How some animals live in the winter season.
The Universe-The Earth	How things live and grow about us.	The big, round earth. The earth moves.
Beyond the Earth	Observing how things look in the sky.	The sun is very hot. The sun is always shining. How the sun, moon and stars help us.
Air and Water	Air is everywhere. Plants and animals must have water. Water in the air.	Air pushes against things. Air moves all the time. Wind helps us work and play.
Rocks, Minerals and Soils	Rocks are very old. Rocks are not alive. Seeds grow in soil.	Rocks help to make soil. Growing plants in good soil.
Conservation	Man, animals and plants use food to have strong bodies.	How to protect, use and enjoy our trees and other plants.
Sound	Hearing—voices, music. Needed tests for hearing.	How we help control sounds in our community.
Liquids, Gas, Solids	Some forms of water—rain, fog, clouds, ice, snow.	Water changes to steam. Water evaporates. Water changes.
Molecules, Elements and Compounds		
Light	All things need light. The sun gives us light and heat.	The sun shines day and night.
Health and Safety	Needs of animals, man, plants for air, food, sunshine, water, rest, play.	Good food is necessary for health. A good home is necessary for health. Man and animals need many kinds of foods.

Subjects in *Science* for Problem Solving	Third Year	Fourth Year
Animals	Types of animals that live on land and in water. Some insects in our locality. The life cycle of some insects and animals.	Some social animals. Animals that live together for special purposes. Some animals that live alone.
Plants	Plants in winter. Changes in plants; life span. Seeds and how they are scattered.	Gardens and food values. Culture and care of plants. How plants reproduce, store food and make green color.
Weather	Uses of thermometers. Some effects of seasonal changes in plants, animals and man.	What is climate? Seasonal changes here and south of the equator.
Magnets	What magnets attract.	The earth is a magnet. Machines use magnets.
Electricity, Energy, Power, Change, Force	Ways electricity help us work and play. Lightning is electricity. Electricity aids the human eye.	Frictional electricity. Uses of a compass. Franklin's discovery.
Homes	Types of animal homes in water, land, trees, ground. Care and protection of domestic animals.	Animal homes of water, land, forests, ground and sea. Some animals that do not care for their young.
The Universe-The Earth	Land and water bodies.	The earth is a planet. The four time belts. The solid and liquid parts of the earth.
Beyond the Earth	Sky and moon changes by day and night. What the moon is like. Stars we see—Big Dipper, North Star, Milky Way.	The atmosphere. The earth's moon. Our sun and other suns (stars).
Air and Water	Uses of air and water in daily life. Forms of water in the air.	Air in and around the earth. How air helps living things.
Rocks, Minerals and Soils	Different kinds of soil. Uses of rocks.	A study of rocks and minerals about you. Uses of rocks and minerals about you. (types of)
Conservation	Growing foods wisely. Using soil products wisely.	Ways to wisely use our food, soil, water and forests.
Sound	Making sound with objects.	Sound conductors. Sounds we hear.
Liquids, Gas, Solids	Heat makes water go into the air. Steam works for us. Water is everywhere.	Air as a mixture of gases. Air in our body.
Molecules, Elements and Compounds		Matter—what is it?
Light	How the moon gets its light. Some ways light helps us: Sun, candle, moon.	Day and night on the moon. Sources of light. Uses of light for better health.
Health and Safety	People change some of their habits with the temperature changes.	How vitamins help us grow. Minerals and proteins help us.

Subjects in *Science* for Problem Solving	Fifth Year	Sixth Year
Animals	Migratory habits of birds and animal life. Some nearly extinct animals. How animals defend themselves from their enemies.	Sea animals. Survival of animal life. Adaptation of animal life.
Plants	Seasonal characteristics of plants. How some plants protect themselves from their enemies. Rare plants: the Venus Fly Trap. Man's dependence on green plants.	Sea plants.
Weather	Climate differences across the United States. What causes weather. Rotation of the earth; reverse of seasons; seasonal changes.	Seasonal changes in the northern and southern temperate zones.
Magnets	Making and using electromagnets.	Review simple magnets. How electromagnets work for us.
Electricity, Energy, Power, Change, Force	Changes made by the sun's heat in plants, animals, work, life.	How machines make work easier. How friction helps us. Insulators and conductors.
Homes	Housing needs of animals, insects, birds, and man.	What electricity means in improving home life.
The Universe-The Earth	The age of the earth. Forces that have changed the earth's surface through the ages.	The earth under the ocean. Life and products of the ocean.
Beyond the Earth	How our nearest star (sun) helps us.	Other planets. (The Sun's family) The movement of planet bodies around the sun.
Air and Water	Air movements. Climate changes. Air pressure.	Air travel. Seeds, birds, fish, animals, man. Purifying drinking water.
Rocks, Minerals and Soils	Minerals and rock uses in your community.	
Conservation	How science helps man, animals, plants. How man can "conserve" plants and animals.	Making and reclaiming soil. Human health a community responsibility.
Sound	Preventing sounds (loud) in homes and office buildings.	The science of sound. Uses of sound.
Liquids, Gas, Solids	How heat changes solids, foods, water, rocks.	Some characteristics of solids, liquids and gases.
Molecules, Elements and Compounds	Molecules—A magnetized magnet. The element—oxygen. Chemical change through yeast.	What scientists tell us molecules are. The movement of molecules. Some elements that we know and use in our homes.
Light	Sun light is indispensable to life.	Compounds that we know and use. Some facts scientists tell us about light. Uses.
Health and Safety	How man depends upon animals and plants. How man and animals are alike in structure-skin, cells and some functions.	Some ideas scientists have given us about health: skin, colds, wounds, poisoning, first aid.

Subjects in *Science* for Problem Solving	Seventh Year	Eighth Year
Animals	Controlling insects Protection of animals, birds, insects useful to life. Reproduction—animal types.	Food. Sport. How nature restores a balance in life. (Locusts and birds.)
Plants	Uses of science in plant growth. Waterlife in the pond (plant).	Uses of Science in our farming industry. Uses of Science in textile industry.
Weather	The Weather Bureau and its work. How climate affects living and non-living things.	Ways in which weather information affects man's life. The movement of air masses around the world.
Magnets	Gravity.	Electromagnets—generators, telegraph, telephone.
Electricity, Energy, Power, Change, Force	Sources of energy—coal. Light, ultra-violet, X-rays. Man's uses for electricity. New sources of energy—the atom. Work of the cyclotron machine.	Uses and dangers of electricity in our homes and work. Making current electricity.
Homes	New ways of heating and lighting our homes.	Home improvements through science. Home responsibilities for the community: water supply, disease control, sanitation.
The Universe-The Earth	The travels of the earth for a billion years. (theory)	How man's work and life in N. C. has been affected by man's control of power, water.
Beyond the Earth	The spinning Earth. More about the solar system and constellations.	Man through science has made and used changes-physical, plant life, animal life. Superstitions about nature.
Air and Water	How our water system works.	Transportation-water paddle to air-craft. The layers of air above the Earth.
Rocks, Minerals and Soils	How rocks are formed: sedimentary, heat-made and changed. Composition and uses of minerals, metals, and alloys.	Types and uses of minerals in your locality and in N. C.
Conservation	Applications of wise uses of our human and natural resources. Make life safer through science, as disease control.	How we can help America's future in natural resources. Community efforts in conserving human resources.
Sound	Speed. How to produce sound.	Using sound in industry. Reducing sound.
Liquids, Gas, Solids	Some gases that man uses, as helium and nitrogen.	
Molecules, Elements and Compounds	Some chemical compounds, as salt, how it is formed. Some things made by chemical change, as plastics and cloth from wood. Molecules.	Protoplasm—chemical compounds.
Light	Newton's theory of light. Huygens' theory of light waves. Speed, measurement, chlorophyll.	Speed. Light year. Light waves.
Health and Safety	Amount and types of food needed. Digestion of food. Assimilation of food.	The function and care of the organs of the human body. Works of scientists for better health and man's responsibilities. Available health services in North Carolina.

THE CHILD LEARNS BY PURPOSEFUL DOING

Teachers are frequently amazed at the amount of persistence and drive that the child has when he has a favorable situation for work on a problem in which he has willingly assumed some responsibility, or on a problem that he is eager about. See him, for instance, on a field trip as he turns the last leaf or stone; out early in the morning to study birds, raking fields, ditches and streams on Saturday for a bit of the water animals or field insects, to books that are well illustrated, to filmstrips. He becomes absorbed in the hay baling apparatus and the electric motor that will not work. *The use of curiosity is a power in science instruction.*

The child wants to explore, to try out what he finds, on himself and on other persons or things about him. He is an investigator. His innate "doing" tendency is an advantage in science instruction. For science study, says Blough and Huggett, should be largely a "doing" experience. So it is well when the child's so called "school activities" fit into his drives.

> It is important to recognize the child's "doing" tendency and for the teacher and children to plan a "doing program."

In "learning by doing" the child takes part in many activities:

Problem solving
Teacher-pupil planning
Discussion.
Experiments (Experiences)
Constructing and manipulating
Observing
Collecting
Consulting authorities
Field trips
Evaluating
Using library books
Using supplementary texts
Using audio-visual materials.
Using creative expression

The methods the group uses, or the ways of finding out, are important. They largely determine the results. If these activities are purposeful, the child through practice should come to know:

1. Desirable social behavior.
2. Scientific procedures.
3. Reliable information.
4. Ways of thinking and acting that will be for the good of all.

> In these activities, the child also grows in writing, spelling, oral and written language and the social studies.

PROBLEM SOLVING

What Is It To The Child?

The word "problem" may be clear to the teacher, yet quite confusing to the child. From association the child may think of it as something to be worked out or solved; to him a problem may be a difficulty that is almost beyond overcoming; it may be an arithmetical example; a personal habit that he cannot cope with. A child wants a bicycle for Christmas very much. Money is the problem. Then the problem is a material thing.

> That a problem may deal with ideas, that it may be a very simple question for him to decide based on information, or that it may be a question which requires extended study is something that the child learns through problem solving.

Children at any level use problem solving methods. They may plant tulip bulbs to see if they produce a like plant; they test a magnet to see if it will pick up cloth, iron or silver.

A sixth grade working on the problem, *What are the values of the weather bureau to us,* found many small problems within it. As example, What are the mechanisms at the weather bureau that we can find out about? Could we make and use a barometer? How do our fishing boats use the information from the bureau? How can weather reports affect the time for harvesting hay?

How do the people on the banks of flood-river areas use the weather bureau to advantage?

> There are little problems and big ones. Big problems have many little ones within them.

Choosing the Problem

Finding problems is easy. Some questions are:

1. Is the problem worth the child's time?
2. Is the problem so difficult or so easy that many children will waste their time?
3. Is it a problem that most of them have studied before?
4. Can we find the materials to solve it?
5. What value will be made of the information?
6. Is it a question for scientists?
7. How many children will be involved?
8. Will the problem deal with a generalization or principle?
9. Will the problem "lift" the group to new experiences?
10. "Is the problem a mere hurdle for the child set up by the teacher?"[1]

What is Problem Solving to the Teacher?

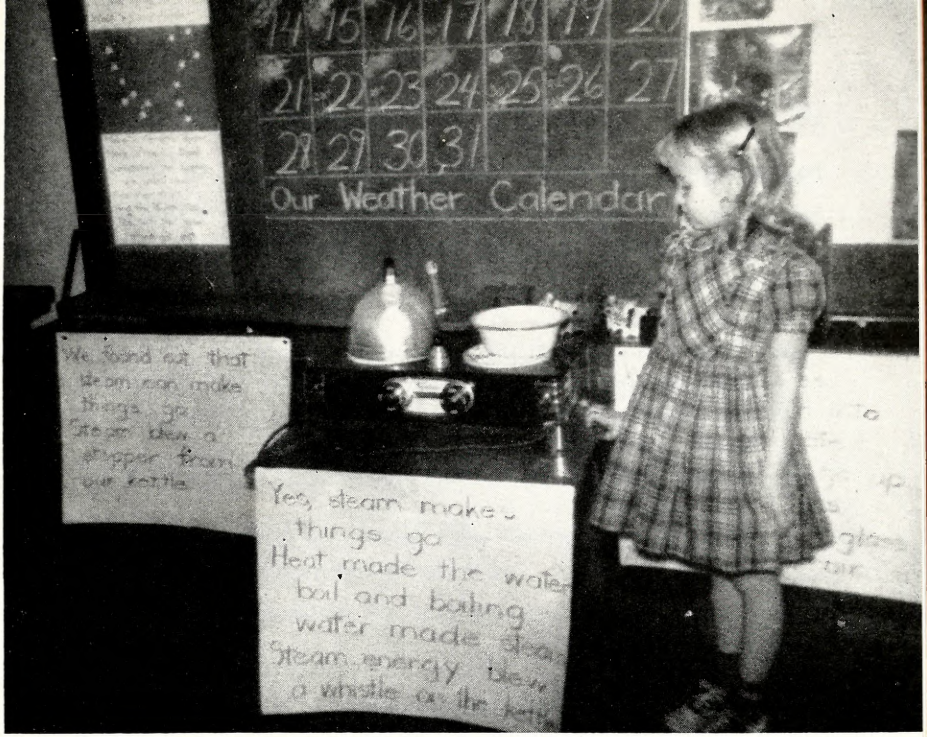
One reference says that a major goal so far as the teacher is concerned is for individuals to improve their ability to solve a problem.[2]

Then, the activities in the science program must be planned to assure the children enough experiences in problem solving to insure the ability to solve problems. To do that the teacher must plan for it.

Every problem cannot be pre-planned, but the *majority* of them should be. Not pre-planned as to what the teachers and children will "say" but pre-planned enough that the teacher will know the topics she will emphasize and "how far" the children will go. The subject sequence chart will help to determine this.

> Problem solving cannot be done in a hurry.

The plans and organization for a study can determine to some extent what the children can accomplish. Their methods of doing can also greatly determine the results.


Our Weather Calendar
Yes, steam makes things go
Heat made the water boil and boiling water made steam
Steam energy blew a whistle on the

Children of any age can come to know big generalizations and principles

> There are inherent *disadvantages* when groups within a class work on many unrelated big topics at one time.

When several groups within a class work on different problems at one time, such as weather, electro-magnets, or sound, the procedure necessarily limits:

1. the number of children who gain information on the problem.
2. the use of materials.
3. the time for reporting.
4. the amount of guidance the teacher can give.
5. the total sharing.

The classroom teacher is the only one in the "room" who knows the program in science from year to year. The children need the type of teacher planing that will keep them from getting bogged down in "little" problems on single objects or things.

The following illustrations show some pre-planned problems and the use of some that "arose":

Examples In Problem Solving.

Example A. Problem: WATCHING PUPILS SOLVE PROBLEMS
(An illustration where the teacher planned what, how, and why he was to teach.)

General Purposes.

1. To provide opportunity for pupils to solve a science problem through planning, discussion, reading and experimenting.
2. To stimulate and broaden interest in science and to raise new problems.
3. To help pupils to see the importance of *using* a scientific attitude.
4. To provide pupils with scientific information useful in solving problems in their environment.

The Plan (subject to revision by class and teacher as lesson progresses).

1. Set a problem.
2. Plan ways to solve the problem.
3. Follow the plan:
   Prepare to read.
   Read to discover how to set up the experiment.
   Organize for experiment.
   Perform the experiment.
   Draw conclusions.
   Check the conclusions to solve the problems.

Observers Discussion

Depending on the amount of time available our discussion may center on such questions as the following addition to any raised by observers:

1. To what extent were the general purposes of the lesson realized?
2. Upon what grounds can we say that such a lesson as this is a success or failure?
3. What might be the next steps in development of the science material begun today?[3]

Example B. Problem: THE SCIENCE OF SOUND AND ITS USES.
(Pre-planning in Problem Solving)

The teacher knew more study on "Sound" was in the developmental plan of Science experiences. She knew some topics that they would work on. She knew that the organization for work would give the children more experience in individual projects, committee work, sub-committe work, and class group discus-

sion. There was pre-planning on the following seven topics which helped to solve the "big" problem:

1. Speed of sound.
2. Conductors of sound (Good and poor).
3. How forms of conductors hinder sound.
4. The ear and its work.
5. The travel of soft and loud sounds.
6. The stratosphere and the effects of distance on sound.
7. Sound in communication. (human voice, radio, TV).

To do those things they:

Read from authorities, discussed.
Conducted experiments on sound.
Saw the film, "Your Ear."
Summarized.
Tried to judge "values."

Example C. Topic: SEA-SHELLS AND MOSS

(Using an Immediate Interest, for a few days)

One of our class group, after a vacation to Florida with his parents, proudly displayed his large collection of shells and

In a few days, when the study was over, the child who brought his shells and moss cleared his collection away and took them home

Individual reports as one of the ways in problem solving

moss. He shared experiences by telling where he found them and what he knew of sea-animals. The children were interested. In our library we had many books about the sea, shells, sea-animals and moss they used.

Example D. Topic: OUR SOLAR SYSTEM
(Using an Immediate Happening in Problem Introduction).

The sixth grade children and I knew that sometime during the year we would study *more about the Solar System.* But the time we did not know. We were completing a study on Electricity when the local theatre began flashing "When Worlds Collide."

Whether pictures of this sort bring forth true entertainment or not is beside the point. That picture started a flow of thinking from my children which could only be satisfied by discussion and study. We rearranged our plans and began. That cannot always be done and need not be, as problem selection does not come that way.

The questions that arose would have stunned "Flash Gordon." For two periods we did not try to pin down; they wrote questions to bring to class. Their questions went into many wonders beyond the earth. Discussion was free.

The next days began with calls for Science. One could see that waiting until the third period would never do. We began.

Earlier studies in Science had acquainted them with various planets, constellations, the earth's axis, the moon and the sun. Now they were ready to go farther.

In getting answers to problems, we *must* ever keep in mind:

> The truth found today may not always be a truth. New discoveries, new facts may arise.
>
> Time changes man's needs and makes new demands.

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TEACHER-PUPIL PLANNING

Teacher-pupil planning activities in a "doing" school program are varied. For example, they plan physical education games, puppetry shows, school gardens, science experiences, dramatizations, picnics, assembly programs, safety factors for study trips (industrial plants), and for clubs. In all this, children have shown that they like to help plan and to be "looked to" as a partner.

All too often, in the "so-called" science period the children read from a science text and discuss the content. They need to use books, many books and references and other aids to learning, to make the subject come to life in many types of activities.

> There is need for genuine teacher-pupil planning in the classroom to make Science more than textbook reading.

They need to plan together on:

1. Judging the relative importance of a problem to study.
2. Group and individual projects.
   a. In the four groups on *The Weather Bureau* study, the child chose his sub-topic group and had time to give his reasons for his choice.
   b. Groups were organized for the topic of study.
3. Materials to use.
4. The relation of science with other subjects, such as: An oral report on a Science topic. (Be sure that the correlations are natural and that they do not "strain a point" to make a correlation).
5. The types of tests and uses.
   a. Do the children help make the test, actually?
   b. Do they judge the value of the test?
   c. Do they plan the best time to give it?
6. The use of their equipment, as science kits, laboratory and movable furniture.
7. Ways to evaluate their activities.

> In genuine teacher-pupil planning situations there is a friendly, busy atmosphere with mutual person to person respect.

The Teacher's Leadership

The teacher is the leader, but not the type of leader that *tells* each child or group what to do. On this subject Craig reminds us, "That some over-zealous teachers answer the questions without giving the children an opportunity to work out a method."[1]

The teacher who comes to know some of the child's abilities and some of his fears can use joint planning to help:

1. The child who fails to carry through.
2. Give consideration to those who feel "lost."
3. The "wordy" ones learn to organize their thinking.
4. The "shy" one to develop confidence.
5. The aggressive to become more co-operative.

6. Challenge the "lazy."[2]

At times the teacher has to exert leadership which affects the group, as when:

. an administration aspect is involved, as use of the school activities bus.
. school planning is done in recording Science units.
. faculty planing is done in selecting and recording Science units.

The Teacher Must Plan, Too. The teacher knows much about subject matter, about materials, and more and more about how children grow. But to do a good job, the teacher still needs to plan. And this does not mean a "plan--book" type, day by day. *It is a problem or unit type planning.* She must know the big problems or questions they will study, and some of the ways that they will attack them. She must know the aids to solving a problem, such as:

—use of texts and equipment.
—library books.

After school, "all by herself"

—audio-visual materials.
—human resources in the community.
—natural resources.

Some of the plans she will write down; some she will think through as she goes about her daily chores, at home and school. For example, to teach some concepts about electricity the teacher, in advance, needs to:

—review what is in the textbooks and supplementary texts for that level.
—try out a few experiments "all by herself."
—think through the many uses of electricity in the lives of those children.
—have in mind and jot down a few science principles and generalizations that she expects to come of the study.

Now, the teacher does not put these *on the board* for the children. She is simply building background that will give confidence to work better with children. After this, one is ready for eager questions and suggestions from the children on how to work. And the children have ideas if the teacher respects their questions and *does not substitute his words* to say it.

When the teacher asks for questions and ways of working, the child has a right to expect that his ideas will be considered. Mutual respect pervades a room quickly. When it is there, the teacher and pupils are better ready for teacher-pupil planning.

If activities are to be purposeful:

Children and teachers will plan together.

1. Problems that are real and pertinent.
2. Problems that are within their scope.
3. Ways of working within the room, such as committee and group work.
4. Group activities.
5. Individual activities.
6. How to set up experiments.
7. Ways to share in collecting materials.
8. The best arrangement for use of movable furniture.
9. To care for, label and use science materials.
10. To evaluate what they do.

Where planning is genuine:

1. The over-zealous child has a place in planning, but not the first and major one.
2. The retiring and passive child grows through responsibilities and status with his peers.
3. They "follow-through" with their plans.

A group of educators remarked on *Planning For and With Children* in these ways:[5]

—"Co-operative planning takes time; it intensifies interests and efforts.—Ruth Strang.

—"Making good plans together is an essential part of education in a democracy."—Alice Miel.

—"Industry has demonstrated that production increases when the workers have a part in making decisions and determining policies."

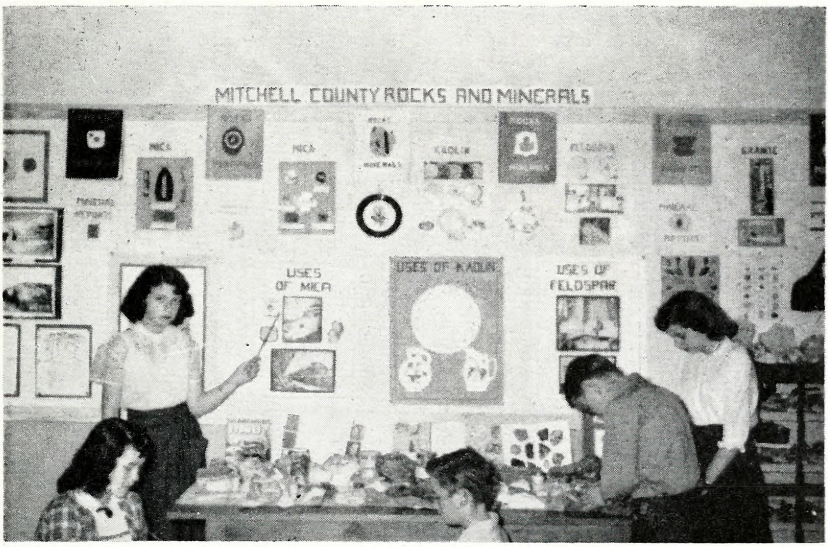
—"But planning is not something which goes on at a stated time—prelude to action—it goes on all the time."—P. Brogan.

Examples of Teacher-Pupil Planning.

Example A. Problem: USES OF ROCKS AND MINERALS OF THIS AREA

Teacher-Pupil Initial Planning

Since more than sixty per cent of the eighth grade class had some income from the non-metallic mineral industry, the work



in mines and in processing plants is "everyday" language to them. Such questions as, "What does your father do in the mica house?", or "What takes place in a feldspar flotation plant?", made an easy approach to teacher-pupil planning for a study of uses of rocks and minerals of this area.

Many questions were asked and listed on the board:

What is feldspar? Mica? Kaolin?

What is each used for? In your home? In other ways?

Why is a pound of mica worth so much money?

What are gem stones?

Where can we find reading material on rocks and minerals?

Where can we go to find some specimens for our room?

After the questions were listed, an important question was chosen for study:

How do the important rocks and minerals of this area affect our living?

Activities suggested were:

- Visiting a mine and a processing plant.
- Collecting objects, showing their uses.
- Collecting books and other reading material.
- Asking authorities to talk to the class.
- Interviewing people in the mineral industry.
- Collecting and labeling minerals.

Planning begins early and extends throughout life

Working plans were:

. Working in committees
. Doing individual projects
. Putting the information in permanent form
. Making field trips

Example B. Problem: SOME CONTRIBUTIONS OF SOME SCIENTISTS TO BETTER HEALTH

Teacher-pupil planning.

Through teacher-pupil planning on the topic, each child was able to identify himself with a purpose. The problem of good health was particularly urgent at that time.

Throat infections were developing fast in the group. Doctors were being consulted. Penicillin was used in some cases. The importance of bacteria combatting drugs and their values was of special interests. The reactions by the children and their speed of recovery were real.

They followed through on a study of the use of modern drugs; on disease parasites; on insect control, the X-ray in dentistry, and man's responsibilities in public health service. The students planned to work in groups or committees, each working on different phases of the search. The phases of work were:

1. Discover of penicillin.
   Source of penicillin. (how it can be produced).
2. Discoveries of Pasteur and other scientists.
3. Cautions in the use of modern drugs.
4. An experiment on cultures.

This teacher-pupil planning saved time in the end. But more than that, the children were "a part of it." The news bulletin board was soon full. The reading table had a collection on "Better Health" and on "Scientists." To do these they visited libraries, used films, used health department materials, used magazines and made posters.

Example C. Topic: WATCHING FOR SEASONAL CHANGES

Teacher-pupil planning.

Children like the symbol dates on a calendar. March 21 said, "Springs begins." It was time to look for signs of spring: The teacher made a chart and planned with the class how to keep it; and she helped them plan to watch for certain things:

Warm days of spring make the soft pussy-willows turn gray. We may hear the voices of the frogs. We may see the robin

looking for a worm. The violets and dandelions look up. Raindrops will fall. The buds on the trees are bigger; the little leaves are coming out. A mother cow with a new baby calf may be in the barn. Maybe there are baby pigs, or maybe there are baby kittens in the hay. We look for a mother hen with some little yellow chickens. The mother bird is making a home high up in trees; she is going to have bird babies from her eggs. Insects now fly by night. Plants come from seeds. A big circus may come to town. LOOK! It's fun to look for changes in the springtime.

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Teacher-pupil planning

DISCUSSION

Children have to learn techniques of discussion. Just more discussion will not do it alone. A classroom climate that stimulates the child's freedom of expression, movements of body, use of materials and furniture, and prizes the exchange of ideas will help. But even in this freedom a child may flit from subject to subject and ramble on and on. He may talk freely without relating what he is saying to a problem, an application, or a science principle.

> The child may 'check up' on the amount of participation in group dynamics but 'check down' in the quality of his contribution.

Children should begin in the first grade to clarify their ideas through discussion. It is good to begin at any grade, if the child has not started. All children should develop power in identifying a problem, evaluating pertinent data, and in thinking critically as to the value of their statements. Discussion needs skillful guidance by the teacher and group leaders.

It is difficult to lead groups and individuals into purposeful discussion. A group can become so aware of their contributions that they lose their spontaneity.

It is well to help children to see that:

a. any type of contribution should be on the subject under study.
b. there is much material; selection is very important.
c. the time element is also important—others need time, too.
d. it is well to plan how many contributions they can have in one discussion period.
e. opinions are usable sometimes.
f. guessing will not do when we need what scientists have found out.
g. the generalization is important, too.

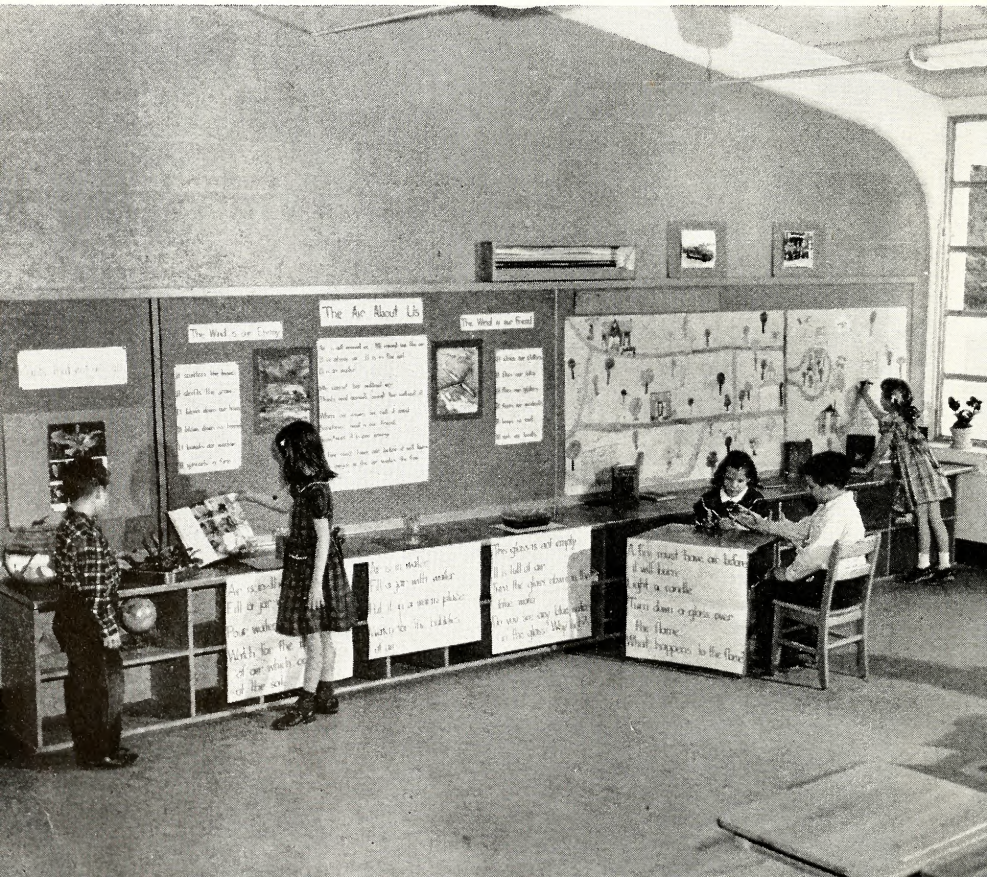
> While the child grows in freedom of expression, he should grow in respect for authoritative information that helps to find the truth.

Discussions Vary In Type There is a place for immediate interest and a place for long time or on-going problem discussions. Different type problems call for different type discussions.

An immediate interest is illustrated in the following incident: In the second and third grade group, a second grade boy brought his snake to school—a beautiful garden snake. During an outdoor game session the snake left his coiled position in his box to explore a more comfortable home in the long tool chest. When the children returned, the discussion by the members of the group went as follows, perfectly unhampered by the teacher:

Did you feed him today, was he hungry? What does a garden snake eat? Did he lift the top off the box? Are the holes large enough to get out? Shall we kill him when we see him? Will he bite me? Will he run us? Which is better, to run him in a box, into a sack or pick him up by his tail?

While the child grows in freedom of expression, he should grow in respect for authoritative information that helps to find the truth



"I read a book about a snake," one said, "he will not hurt you." One group got a box, one group held the large Indian tent bag, while the braver few stood by to get the tail. The snake was found and captured.

There were many irrelevant questions asked, but the teacher selected only the pertinent ones to put on the chalkboard following the children's questions. The children were absorbed in discussing facts towards the solution of their own problems. It was important to them. The teacher used the incident to help the children to see what was happening—

. What caused the snake to get away?
. The food and habits of the snake.
. How did he get out of the box?
. Plans for catching the snake.

Unless *immediate happening* problems which are unrelated to the group activities are skillfully used, it results in unrelated, superficial discussions. The alert teacher considers how far to go, how to relate immediate interests and *when to stop.*

Science lends itself to "experience telling" by children. To a degree, it is very good. Good for the child in mental hygiene, good for oral language power, good in helping the child clarify his ideas. The teacher must know when it becomes a waste of time.

> It is as important to know when to stop a discussion as it is to know when to start. Rambling on does no good.

An on-going problem discussion should be planned by the teacher and the children. In the *on-going problems,* for example, in a study on weather, the teacher and children plan a study on climatic differences and how it affects the life and work of the people at home and in other lands.

Objective, purposeful discussion is a technique that is needed in training leaders for a democratic way of life. This is not leadership for a selected few but for each child to be the best leader that he can become.

> In group discussion the slow moving child should often have a chance first, else it will "all be told" when he gets a chance to be a member of the group.

Discussion requires guidance:

It comes out of on-going problems.
It comes out of immediate happenings.
It helps to clarify a problem.
It helps to answer problems.
It must draw on many resources.
It must rely on authoritative sources.
It should point to finding the truth.
It should deepen respect for another's point of view.

> Discussion is valuable. However, says Craig, discussion has shortcomings—it cannot of itself produce reliable explanations of phenomena, for in the end, to get at the truth, we must secure assistance from other methods.

Illustrative Excerpts Of Purposeful Discussion.

Example A. Topic: CONDENSATION OF WATER

"My glasses are cloudy and I can't see," said a fifth grade child as she entered the classroom one cold morning. The teacher directed the attention of the group to her statement. These questions were discussed in rapid succession:

"What makes Jane's glasses cloudy?"
"Where does the moisture come from?"
"How did it get there?"
"Why did it condense on her glasses?"

Those questions were listed to come up again in a study of *Water Changes In The Air.*

Example B. Problem: INSECT—METAMORPHOSIS

When the children learned that some insects have complete life changes, they were interested in knowing more about them, especially the ones about their homes. Through class discussions they decided to "hunt" around their homes or near by, in the following ways:

1. Inspect the grass carefully for katydids, grasshoppers, ants and bumblebees.
2. Look under boards and bricks laying around on the ground to find crickets, ants, and bugs.
3. Look on trees for caterpillars and mole crickets.

They followed through with their plans

4. Pull the bark from dead trees to find different kinds of insects.
5. Examine the leaves of trees and plants for tiny leaf hoppers and plant lice.
6. Look in the air for mosquitoes, wasps, hornets, gnats, dragon flies, and many other insects.
7. Look among blossoming flowers for bees and butterflies.
8. Examine tree branches for cocoons and scale insects.

Example C. Purpose: Simple Machines: Lever, Inclined Plane, Wedge, Wheel, Axle and Pulley

After watching some housing construction, the class discussed the different things that were being done with machines. They were awed at the number of machines they use each day. Each child brought in at least one simple machine and classified it under one of the above machines.

Different ones explained why each machine was so classified and how it made work easier. For example, they took a minature sewing machine and a pencil sharpner and explained that in each of these could be found several of the simple machines. A well was designed by three boys to show how pulleys worked.

The generalizations will come later—we are still at work.

Example D. Problem: Electricity—In Cars

In our study on uses of electricity, we used an old car storage battery to find out: *How this black box could make a car run.*

Jack, who helped at times at a garage, cautioned the class that a battery could be a dangerous thing. Another brought out that battery acids should not touch the skin. Questions

were: "How can we handle a battery safely?" "Why do we want to tear the battery apart?" All of this took place before they touched the battery.

One class member explained: "There is acid in a battery. When this acid mixes with the lead plates in the cell, it produces a form of electricity. This is sent through wires to the starter and turns the engine." Other questions continued.

"What are cells made of?"

"Is it necessary to have three cells to make a battery?"

"What do you know about wet and dry batteries?" "What are some of the uses of wet and dry batteries?" "Do they work the same way?"

Out of this discussion, committees were organized to study these problems in order to answer some of the questions. Jack was helpful.

Example E. Problem: SOME WAYS THE DISCOVERIES HAVE CHANGED OUR WAYS OF LIVING

Informal planned discussions bring good results in our 8th grade science class activities. We were beginning the problem.

Science has changed the clothing we wear. Community living now and long ago "takes on" new meaning through science with this third grade group

CLOTHING
How has science changed the clothing we wear?
Animal skins were used for making clothing long ago
Cotton grown in the south was at first separated from the seed by hand. Now we have cotton gins and weaving mills where many people work.
Products from cotton seed
Sheep raised on ranches and farms are sheared in the spring and the wool sold to the mill where it is woven into blankets and warm winter clothing.
Nylon
Silk
coal
air
water
Fur
Rubber comes from trees growing in hot wet lands.
Leather is made from the hide of such animals as horses, cows, pigs, alligators and others.
The Pilgrims could spin and weave wool and flax into cloth which
Cotton linters or wood make Rayon

There was a brief discussion to see that *everyone* clearly understood it.

Work groups on sub-topics were thoroughly discussed. Each group elected a chairman and a secretary. The teacher and children made the following outline.

1. Methods of heating and ventilating homes and other buildings.
2. Methods of transportation and communication.
3. Ways of lighting houses and streets.
4. Building materials.
5. Making uses of forces—electricity, steam, wind, water.

When all groups were ready, all material was put on display in the classroom and each group described what it had found by oral reports, charts, and picture illustrations.

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USING EXPERIMENTS

Children like to perform experiments. A real problem, some materials to "tinker with," space, and time is all that most children need to be into one. Blackwood says, the term *experiment* may have a very special meaning among scientists. It is setting up a procedure to find out something about materials or forces and following through to see what results. But among children it is any activity in which they manipulate materials and watch and see what happens. There are many activities which children are likely to call experiments, such as:

—seeing what substances magnets attract.
—wiring an electric bell to a battery and switch.
—building an electric motor from given parts.
—manipulating and observing an ant colony.[1]

When To Use Experiments A science experiment is used in problem solving when there is a need for it, like the use of excursions, books, source references, or audio-visual materials. *It is one of the techniques of learning.* Like other aids to learning *its value depends* upon the degree that it is helpful to the child in solving a problem.

> In a good experiment there will be pre-discussion; accurate performance; exact relating, oral or written, to help insure valid conclusions.

Performing Experiments At times the teacher performs the experiment for the children to observe; at times the children do it. But in the main, if an experiment is too difficult for the children to perform, *it is out of place for them at that time.* Experiments need teacher leadership and the children's performances. As an experiment goes on, children can be great helpers. Many times they think and work *so fast* that the teacher has to be alert to insure time for:

—good teacher-pupil planning
—group and individual participation
—assembling materials
—applications of what they find
—evaluating

1. *Teacher leadership.*
   —Experiments should be kept simple in the elementary school.
   —Do not attempt high school and college experiments for children "to look on."
   —It should be worthy of the time and effort put into it.
   —A separate laboratory room is not necessary in the elementary schools.
   —The overzealous child should not always usurp time and opportunities at the expense of other children.
   —Take time to hear what the child says as he works.
   —Use all the apparatus available on the child's level of understanding.
   —Be familiar with books of experiments designed for children in the elementary school.
   —Where possible have the apparatus near the center of the group.

Selecting the Experiment

Experiments cannot wisely be selected by grades. For example, children in the elementary grades will enjoy and profit from the simplest experiments on evaporation, atmospheric pressure, and use of magnets, which are usually made in the primary school, if they have not had those experiences. It is encumbent upon the teacher, however, to see that the upper grade group does not stay in the beginning level, just as they do not attempt experiments involving concepts for high school work far beyond their understanding.

> Watered down college and high school experiments are out of place in the grades.

Planning Controlled Experiments

"When an experiment is expected to show what happens as the result of some specific cause, it needs to be planned so that what happens can readily be seen to result from this single cause. Such an experiment is called a *controlled experiment.*

For example, children ask the question, "What causes bread to mold?" They may guess (make the hypothesis) that moisture is necessary, or that exposure to the air is necessary, or that warmth is necessary. Then to get evidence on the effect of one or more of these factors, a *controlled experiment* may be planned.

Suppose the children decide to find out the effect of moisture. They might state the problem, "Does bread mold require moisture for growth?" A controlled experiment might be set up this way:

(1) Expose a slice of bread to the air. Permit it to dry. Then divide it into four pieces.

(2) Dampen two pieces and place in a covered dish. Leave two pieces dry and place in a covered dish.

(3) Place both dishes near each other in a dark, warm place.

In this experiment everything is the same except the moisture. If mold grows on the moist bread but not on the dry, it is good evidence that the mold needs moisture for growth. Using *dry* bread as a *control* helps us see that mold would grow on the dry bread. If only dry bread had been used and the mold had not grown, we might think it was because of the wrong temperature, or the wrong kind of light, or even the wrong kind of bread. *Our question was about moisture, so dry and moist bread were used and all other factors kept the same in both cases.*

Sometimes children learn a good deal in the process of discovering that *control* should be used where they had used one in their original experiment. Because there was no control, their conclusions may be challenged by the teacher or other children. In such a case the experiment may need to be repeated with a *control* properly planned.

For example, a third grade boy was showing his classmates some sprouted bean seeds. He said, "It has to be warm for beans to grow." A classmate asked why and the first boy replied, "I did an experiment. I put some moist bean seeds over by the warm radiator, and they sprounted." At this point several children were ready to question the statement and one said, "Maybe they would have sprouted just as well in a cool place. Isn't it cool in the ground?"

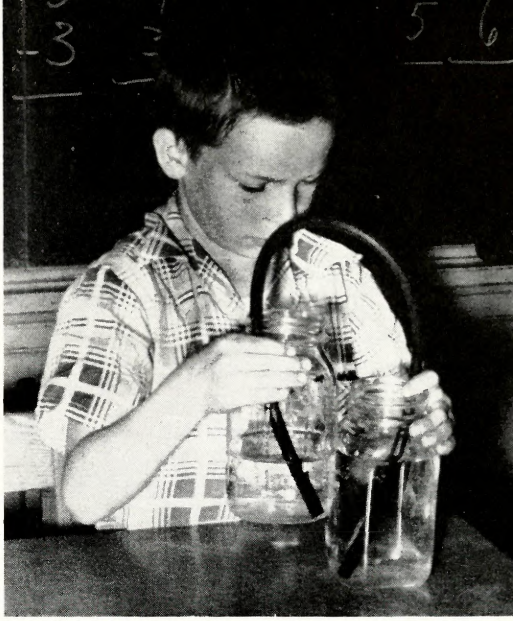
As a result of this questioning, the first boy and the group decided they had better plan another experiment to check the effect of temperature a little more closely. These children, without using the name *controlled experiment,* were seeing the necessity for a *control* when checking on the effect of a specific variable.

Very often experiments described in books are not set up as controlled experiments. So in using experiments from books the teacher and children should give some thought to whether the suggestion needs to be replanned or modified to include a *control.*

Some questions which suggest the need for controlled experiments in getting the answers are:

Do plants need sunlight to grow?
What causes water to evaporate?
Do plants lose water from their leaves?
Does grease stop iron from rusting?
Does rusting use something out of the air.
Does wind cause water to evaporate quicker?
Do seeds need water to germinate?
What kind of soil is best for grass seed?
Does evaporation cool things?
Does black absorb heat better than white?[2]

> The facts proven by the child is not the whole objective. The manipulative experience directed by a scientific way of thinking has appreciable value for him.



Applications Children need help in making application of the concepts and generalizations they have had. What shall be done with the answers from science experiments or activities? How do we use the information? At home? In our lives?

If moisture causes mold on bread.	How do we keep bread free of mold?
If iron is rusting.	How may iron rusting be prevented?
If the tomato vine does not produce?	Do you use authorities on soil and culture of plants?

Some Samples Of Experiments Used In Problem-solving.

Example A. Topic: THE USE OF THE SIPHON

They used two quart jars half full of water. A rubber tube filled with water was inserted into each jar. When either jar was higher, the water ran into the lower jar. When the surfaces of the water in both jars were level, the water did not flow. The teacher knew that in later grades the children would say: *"Liquid travels from a higher level to a lower level through a tube. The liquid stops flowing when both surfaces are level."*

Example B. Problem: DOES AIR HAVE FORCE?

The children boiled an egg until it was hard; cooled the egg and removed the shell. They placed the egg at the mouth of the milk bottle to see if it would drop into the bottle. This proved unsuccessful. Paper was crumpled into the bottle and burned. The egg was placed over the bottle while the paper was

burning. The children watched the egg to see what would happen. The egg dropped into the bottle.

The next problem was to remove the egg from the bottle. They filled the bottle with water and emptied the burned paper. The bottle was turned up and blown into and the egg popped out.

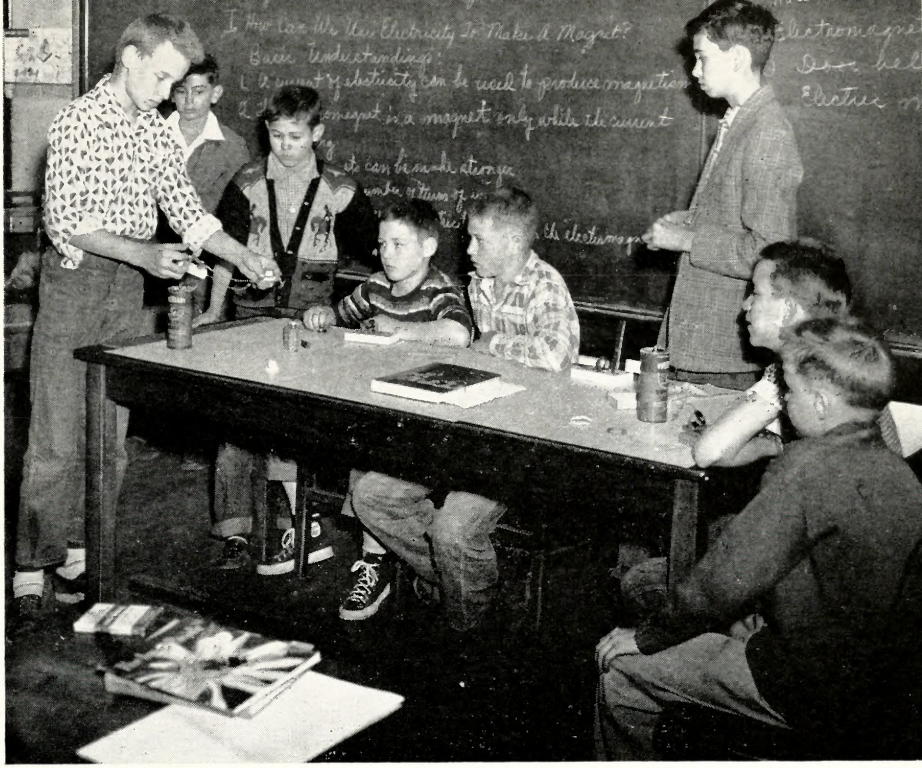
Result: This experiment proved that air has weight and that it was real. The air that forced the egg to drop into the bottle was heavier than the air inside the bottle.

Example C. Topic: PLANT LIFE (SEED REPRODUCTION)

Plants produce many more seeds than survive.

1. Estimate the number of seeds produced by any one plant.
2. Secure two glass panes of the same size. Cut a piece of blotting paper the same size. Wet the blotter thoroughly and lay it on the glass plate. Arrange some seeds on the blotter. (Be sure that the seeds are not pointing the same way.) Over the seeds place the other glass plate. Tie the two plates together firmly. Stand the glasses on edge in a pan containing about one-half inch of water. After the seeds sprout, notice:
3. Concepts:

   Roots turn down and shoots turn up.
   Seeds which were wettest or driest do not sprout first.
   If plants grow long enough, they eventually die.
   Not all seeds germinate.
   Seeds produce their own kind of plant.



Example D. Problem: ELECTROMAGNETS AND THEIR WORK

One type of an electromagnet.

The children had seen a film showing a huge magnet picking up scraps of metal and junk and loading it on a freight car. The magnet was controlled by electric current and was called the electromagnet and its work was new.

How to Make One Kind:

No. 1 We wrapped insulated wire around a nail fifty times. The ends of the wire were connected to a dry cell. We held the nail near some filings (iron) and some tacks and found that the magnet did not work.

No. 2 We connected the wire to two dry cells and found that it would pick up a number of tacks.

No. 3 We wrapped the iron nail with a hundred turns of wire and found that the electromagnet had more power.

No. 4 We tried wrapping a glass rod and a piece of wood and that we had no electromagnet.

Concepts:

—Two kinds of magnets are: The natural (permanent) and the electromagnet.

—The electromagnet must have a complete circuit through which an electric current flows.

Electromagnets are useful to man: They can be made strong and can be cut off; lift objects; are important parts of telephone and telegraph instruments; can be used in doorbells.

Example E. Problem: HOW PLANTS GET WATER FROM THE ROOTS

These children are performing an experiment to find out how plants "take in" water.

They put an equal portion of red ink and water in a glass. Then they carefully took up one of the plants to save the roots and hairs, and put it in the red-ink water and let it stay for two nights. They saw that the red solution had gone up into the plant, beginning through the roots.

That was simple, but it was difficult enough for the pupils in my first and second grades.

They will later call this osmosis.

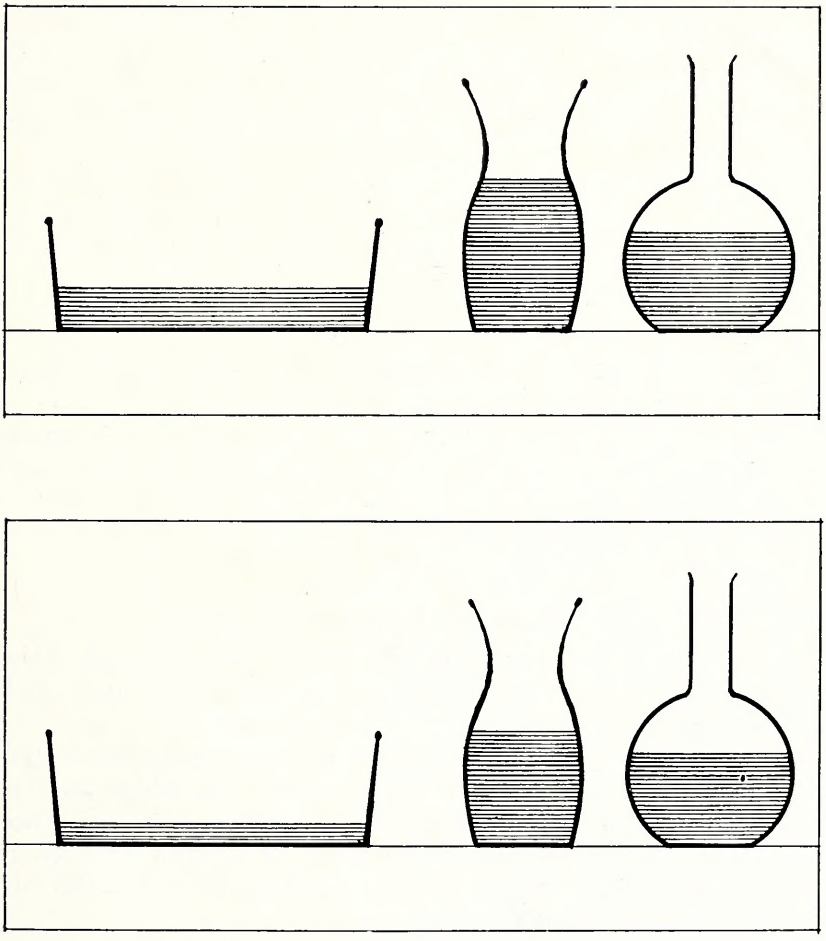
Example F. Problem: DO LAND AREAS HEAT AND COOL MORE RAPIDLY THAN WATER AREAS?

Dark colored objects heat more rapidly than light colored ones—These cans, exactly alike except that one has been painted black, receive the same amount of light and heat, yet the black can is 10 degrees warmer inside. For black and dark colors absorb heat much faster than light colors. Fill the cans with warm water (not more than 100°). Within an hour the water in the black can will be several degrees *cooler* since dark bodies give up their heat much more rapidly than light colored ones.

These experiments explain why land areas heat up and cool off much more rapidly than water areas do. Water, because of its structure, is heated slowly by the sun; and also gives off its heat much more slowly, just as the shiny can did when filled with warm water. Large bodies of water tend to moderate temperature changes on nearby land areas.

Example G. Problem: WATER EVAPORATES FASTER THE MORE EXPOSED IT IS TO THE AIR

Each of three vessels contained exactly the same amount of ink-tinted water. They were filled on Monday morning and left alone. The lower picture shows them on Friday morning. The children measured the water and found that more than one



pint had evaporated from the oblong dish. They found about half pint gone from the center vase, but only a little from the boiling flask. Each vessel exposes the water to a very different air surface.

Water is composed of molecules which are constantly in motion. Some fly off into the air, which we call evaporation. The greater the surface exposed to the air, the greater the opportunity for the escape of water molecules. This explains in part why shallow lakes and ponds often dry up in times of drought, while wells and deeper bodies of water show little loss.

Example H. Problem: HOW DOES WATER CHANGE IN FORM AND FORCE WHEN IT FREEZES?

Water expands when it freezes—A screw-cap bottle was *completely* filled with water and the cup screwed on tightly. Then it was placed in a freezing mixture of ice and water. Salt was added to lower the temperature below the freezing point of water. In about fifteen minutes the water froze and broke the bottle.

Sometimes the bursting bottle will break with a loud report. During winter, freezing water causes much damage to pipes, automobile radiators, houses and buildings, and other places where water is enclosed.

Example I. Problem: WHAT CAUSES FOG?

Pour about a half-pint of hot water into a milk bottle. Next, place a large ice cube in the mouth of the bottle.

When the cold air from the ice cube meets the warm moisture rising from the hot water, fog is created by condensation. This is how clouds are formed—moist air rises from the earth to cooler air in higher levels. A fog is really a cloud at ground level.

Example J. Problem: THE FORCE IN COMPRESSED AIR

The student is well pleased with his fountain. He blew through the glass tube which was smaller at the upper end. When he stopped blowing, the fountain began.

The air that he blew into the bottle went through the water. The bottle could not expand as the balloon did, which the girl on the right blew up. The air was compressed in the space above the water so tightly that when he stopped blowing, it immediately expanded. It pushed with more force than the air outside of the bottle.

Two other children were reversing this action by expanding and driving out part of the air in the bottle with heat. While the fire was burning in the bottle, they placed the egg in the mouth of the bottle. The air outside the bottle forced the egg into the bottle for it had more force than the air left in the bottle which contracts when it is cooled.

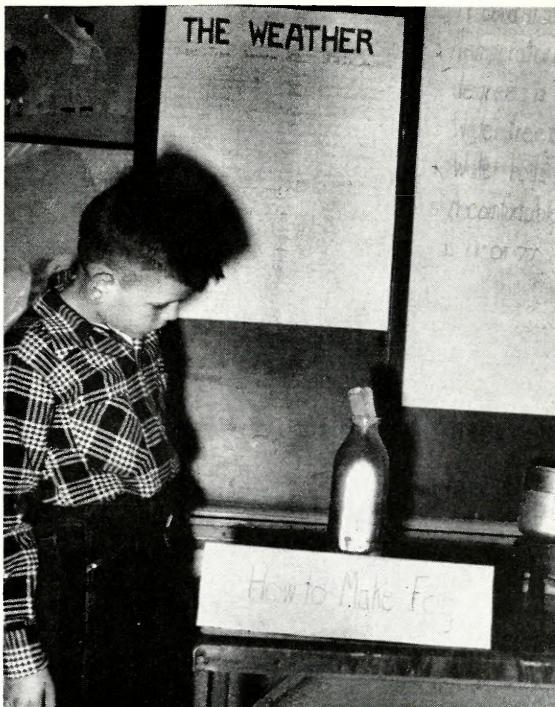
Example K. Problem: SOIL EROSION

An applied experiment (activity).

Many of the eighth grade boys live on farms and have been able to give valuable discussions and experiments on soil, especially in farming.

As the unit progressed, it was found that much of the top soil washed away in our locality because of soil erosion. Discussions showed that this was especially true on hilly land where the proper method of plowing was not used. One boy, who lives on a farm, performed an "experiment" (activity) which showed the advantages of a special type of plowing for hilly land.

This experiment shows how to plow land with a gentle slope by using terraces. The water then cannot run rapidly down hill. Much of the water soaks into the soil and is stored there for future use by the plants. This information has already been used by some of the boys who have this hilly land. It will be meaningful to anyone who plans to farm on sloping land sides.



Example L. Problem: To Prove That The Earth Acts As A Magnet

After the children had used a compass to locate directions on the school grounds and in the classroom, one child said: "But maybe this compass was *made* so that it *has* to point toward the North. How do you make a compass, anyway?"

They learned from a science text how to magnetize an ordinary needle. "All you need are a marked magnet, a steel needle, a flat piece of cork, a knife, a dish(glass or china). Rub the needle from the center of a magnet towards one pole. Keep rubbing. Do not rub it back and forth. When the needle is magnetized, test its ends with the S pole of the magnet. The N pole of the needle will be attracted by the S pole of the magnet. Cut a tiny groove across the cork for the needle. Now float the cork and needle. Be sure it does not touch the sides of the dish and be sure there are no magnets nor magnetic materials near the dish. The N pole of the needle will point towards the earth's magnetic pole in the north. The S pole of the needle will point towards the earth's magnetic pole in the south."[1]

Texts and diagrams led them to put the newly magnetized needle through a thin cork and to float it in a dish of water. This done, they saw that their own compass, the needle, pointed North and South as did the commercially bought one.

Example M. Topic: Fire Needs Air

To prove that fire needs air we used four jars of different sizes and four candles. We lighted the candles and placed them

under the jars. We found that the candles in the largest jar burned longest, but that each would go out in time. The more oxygen (air) in the air the longer fire will burn.

Example N. Problem: THE FORCES OF AIR IN AIR FLIGHT

Our experiments were performed following the discussions by the class on "The Forces of Air in Air Flight." The discussions were on: The weight and forms of objects which affect flight through the air; air is a substance; and air exerts force.

To illustrate air pressure on a given surface, a glass was filled with water. A piece of cardboard was placed over the top of the glass. When the glass was held upside down, the cardboard continued to hold to the glass. This demonstrated that air exerted a greater force on the cardboard than did the water.

To show that air is a real substance, one of the gases, that is a component of air, was prepared. This gas was *oxygen.* The apparatus was set up with a gas generator and collecting bottles. Manganese dioxide and potassium chlorate were placed in the generator and heated. Oxygen was collected in the bottles. As the gas was rapidly given off, the water in the jar began to recede. The pupils were then able to see that some real substance was forcing the water from the jar. The bottle was then placed neck down in a large beaker of water. Since the water failed to rise in the jar, it was proven that there was some substance keeping the water out.

Example O. Problem: THE IMPORTANCE OF CALCIUM CARBONATES IN OUR LIVES

In studying the importance of calcium carbonate in our lives, a group of sixth-grade pupils tested a piece of chalk, a pearl button and a piece of bone. They dropped them into hot vinegar. If a substance contains calcium carbonate, bubbles of carbon dioxide will be given off.

On the table there is an uncooked, unbroken egg which has been left in strong vinegar overnight. Since vinegar is an acid (acetic), the shell of the egg has become soft because the calcium carbonate in it has reacted with this weak acid just as the H Cl reacted with the other substances containing this compound.

Experiment References for Teachers

Teachers will want to have a "working" acquaintance with these books on Experiments:

1. Arey, Charles K. *Science Experiences for Elementary Schools.* Teachers College, Bureau of Publications, Columbia University, N. Y. 1942. 98 p.
2. Beeler and Branley. *Science Experiments.* Crowell, New York. 1947. 115 p. Gr. 3-8. (From disappearing ink to jet propulsions).
3. Beeler and Branley. *More Experiments in Science.* Crowell, New York. 1950. (a wide variety of subjects) Gr. 5-8.
4. Baer, Marian E. *Experiments Without Fire.* Rinehart, N. Y. 1947. 114 p. Gr. 1-5. (simple Gravity, balance, air, water, sound, color).
5. Freeman, Ira M. *Invitation to Experiment.* Dutton. N. Y. 1940. 238 p. (many phases of physical science) Gr. 7-9.
6. Lynde, Carleton J. *Science Experiments With Home Equipment.* Ed. 1950. Gr. 3-9.
7. Lynde, Carleton J. *Science Experiments with Inexpensive Equipment.* Ed. 1950. Gr. 4-12.
8. Lynde, Carleton J. *Science Experiments With Ten Cent Store Equipment.* Ed. 1950. Gr. 4-8.
9. Parker, Bertha M. *Science Experiences.* Row-Peterson and Co. Evanston, Ill. 1952. (17 subjects—181 experiments for the elementary school).

References.

1. 2. Blackwood, Paul E. *Experimenting in Elementary Science.* U. S. Office of Education. Washington, D. C. Bulletin No. 12

3. Beaucham and others. *Discovering Our World I.* Scott. N. Y. 1947. p. 151-52.
4. Blough and Blackwood. *Teaching Elementary Science.* U. S. Office Bulletin No. 4. 1948.

CONSTRUCTING AND MANIPULATING

The desire that the young child has to manipulate and construct with his toys may show itself in the later grades also if he is given the chance. He may like to make, to tear apart, to try out, to rebuild. That is an urge that we can use in the teaching of science.

> Children grow through manipulating and constructing when the project is an aid in developing a topic and is extending an interest.

A fifth grade group in studying "Causes and effects of changes in the earth's surface" made a volcano. The *exactness* which was required to make it work was one evidence of a science principle in experiments. A seventh grade made a filter system for their water. It worked. An eighth group in a unit on "Our Uses of Electricity" rewired, remade and constructed anew the items described in the activities on p. — of this bulletin.

While construction work is good and has a place, we must be cautious one one point.

> A series of individual or group "making" projects do not constitute a science program. It is only one of the ways the child learns by doing.

Children can do the following and other typical ones as the need arises:
For illustration:

In a first grade, they can:
—Make animal boxes that fulfill the requirements for a good home.
—Construct a train and make it "work."
—Construct a lever to find its uses first hand.

—Manipulate plants to find out conditions that help them to stay green.

In a second grade, they can:

—Manipulate objects to see which object has more air pushing against it—a penny or a sheet of paper that falls a distance to the floor.[1]

—Make a needed insect net from an old coat hanger and a bag.[2]

In a third grade, they can:

—Make a feeding station outside their window for the Juncoes (snow birds) that need food when they come in the winter.[3]

—Manipulate the thermometer and record temperature.[4]

In a fourth grade, they can:

—Make an electromagnet with a nail, some doorbell wire and a dry cell.[1]

—Manipulate the film-strip machine to see a picture of the moon.

—Construct simple rain gauge; bottle barometer.[2]

In grade five, they can:

—Make a compass.

"All you need are a marked magnet, a steel needle, a flat piece of cork, and a dish of water. Be sure that the dish is made of glass or china. A compass will not swing around freely in an iron pan. — — —"[3]

—Show that air can expand when it becomes warmer by manipulating an old (wrinkled) full balloon over a warm radiator.[4]

In grade six, they can:

—Make the sun's family to scale.[5]

—Show that sound is produced in many ways.[6]

—Construct a calories chart of foods grown in the community or sold in a local grocery store.

In grade seven, they can:

—Construct an aquarium and a vivarium.[7]

—Extract chlorophyll from spinach leaves.[8] (Place a spinach leaf in a test tube, cover with 70 per cent alcohol, place the tube in a beaker of boiling water, allow it to stand for several hours, note the pale leaf and extracted chlorophyll.

—Construct a barometer.[9]

In grade eight, they can:

—Manipulate simple engines.

—Make or assemble the parts of an airplane.

—Manipulate the chemicals (non-poisonous) that destroy harmful chewing and sucking insects.[10]

When the construction helps to solve the problem underway, it is helpful. Any project or activity which is done especially for an exhibit or a fair does not warrant the child's time.

Examples of Constructing and Manipulating Experience as Aids to Learning.

Example A. Problem: GROWING AND CARING FOR PLANTS IN OUR SCHOOL GARDEN

We talked together about things we needed for our school garden. Rich dirt, bricks for a border, flower seeds and vegetable seed or plants. The children spaded and dug the ground; they found bricks and laid a border. They brought rich dirt and fertilizer in bags and boxes from home.

They wanted to eat as well as to look at the garden, so we planned to grow winter spinach and lettuce in outdoor beds. They kept a chart record of the things planted; how long it took them to come up; and what happened to them.

Now spring has come. The lettuce is large enough to eat. We picked it and made lettuce sandwiches for our mid-morning lunch last Wednesday. We will let our spinach grow a little longer.

Example B. Problem: WHAT DO WEATHER INSTRUMENTS TELL US?

In the problem, "What Do Weather Instruments Tell Us," the class of fifth and sixth graders read that air pressure is measured by a barometer. "A barometer?" someone asked. Descriptions were read of different kinds. We saw one in the high school science department. In one book we found suggestions for making a barometer which started us on other *"home made" weather instruments.*

For the "milk bottle barometer" we need a bottle with a piece of balloon tied over the top, and a drinking straw glued to the piece of balloon. As air in the room is warmed, the straw moves up and down. We marked its position on a chart.

A "water barometer" was made by using a bottle and a jar, filling each one about two-thirds full of water. As the temperature in the room varies, the water level in the bottle varies.

The anemometer was made from a small rubber ball cut in

half, a coat hanger, fishing cork, and a syrup bottle with sand in it.

The wind vane or weathervane was made of cardboard, a bottle with sand in it, a coat hanger, and a cork.

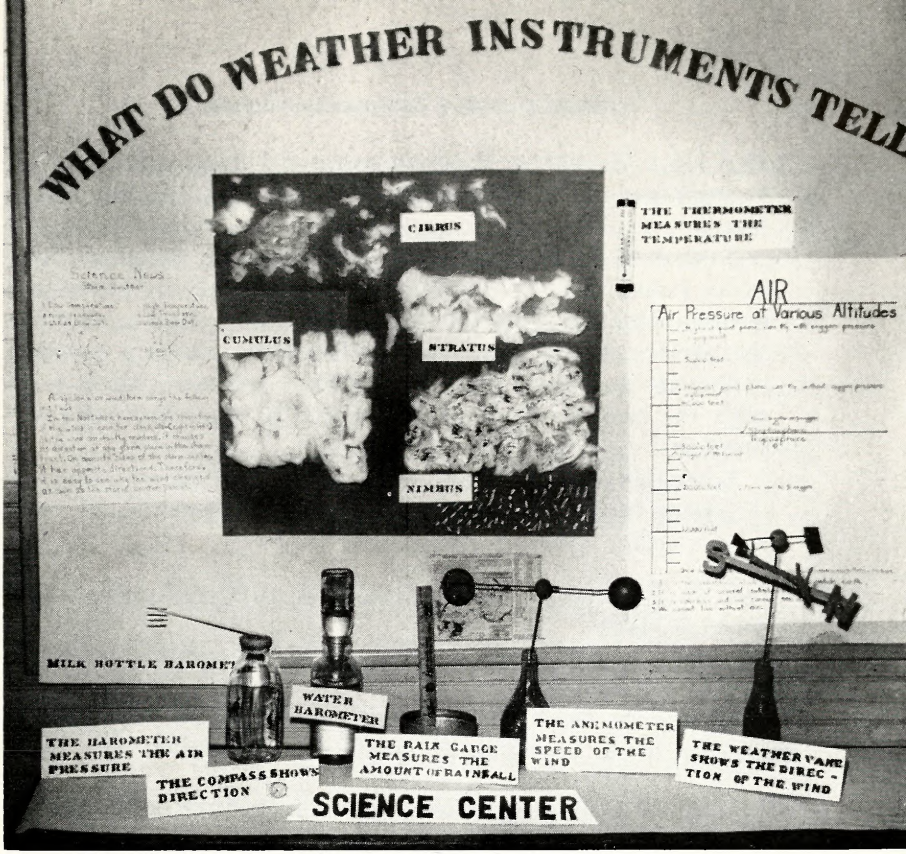
To make the "rain gauge" we used a one pound coffee can with a ruler glued upright to the inside of the can.

We found in another text that a "humidity barometer" can be made from paper treated with a chemical that is sensitive to moisture.

In a solution of cobalt chloride (1 spoonful to a half glass of water) dip pink crepe paper; let this dry and dip it a second time. Then after it has dried, cut it into strips. Fasten outdoors in a sheltered spot so that outside air would reach it but not storms.

When the humidity is low (the air dry) the paper will be blue; but when the humidity is high the paper will be pink. When the paper is pink the children know that moisture is collecting in the air and that precipitation might follow. When it is blue, fair weather might be predicted.

Our Room Weather Predictions Chart: (Not Perfect)



1. Temperature—
2. Barometer—
3. Winds—
4. Humidity—
5. Condition of Sky—
6. Precipitation—

Example C. Problem: How To Make Simple Electrical Repairs in the Home?

Several children felt the need to know something about how to make simple electrical repairs in the home. They learned by doing these things in the classroom: How to repair light sockets, splice wires, and repair electric cords. Each child explained the steps he followed in his construction.

One child explained the repair of an electric cord as follows: "This cord was worn out. I removed just enough of the covering so that no frayed ends were left. I wound each wire separately with friction tape. Let the tape overlap. Then I held the two wires together and wrapped them with the tape."

Example D. Topic: Self-Testing Device, by the Children

Question and answers board.

To make a question and answer board, you need one piece of plywood 12 x 12 x ¼ inches, and another piece of plywood

12 x 4½ x ¼ inches, 12 stove bolts with taps, one Dry Cell Battery and about 112 feet of wire. First nail the top to the front.

Next drill six holes on either side, then put the stove bolts in the holes. Then drill a hole in the middle of the board and put the flashlight bulb in it and conect it with a wire from the battery. Put a wire from each bolt that asks a question to the one that gives the answer. When you touch these bolts with the two wires connected to the battery the light will come on.

You can have a lot of fun with this game. You may use any questions that you wish, and you may change them as often as you wish.

Example E. Problem: HOW TO CARE FOR ANIMALS AND PLANT LIFE AT SCHOOL

Making and caring for a vivarium was serious business to the seventh grade class.

They used an old aquarium, put sand at the bottom, rich dirt next, then moss. They planted small pieces of woods fern, three

Making the containers, balancing the life and caring for and observing "what happens" in a part of science. This activity should **not** be repeated grade to grade

kinds of begonias, an African violet, and a long stemmed red rose cutting. They grew rapidly and the violet and begonias bloomed beautifully. The begonias grew so rapidly that we had to take them out three times and replace them with smaller cuttings.

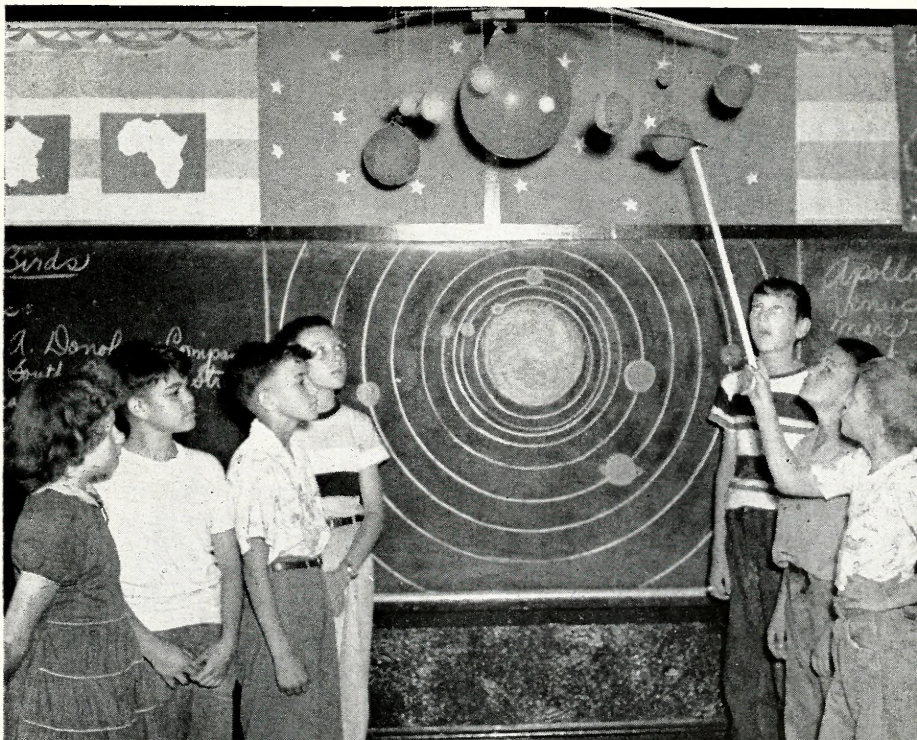
Two salamanders were added. One died. The other one stayed hidden most of the time but he was alive because he ate the worms and liver left for him. During that time they engaged in much "salamander talk" and readings.

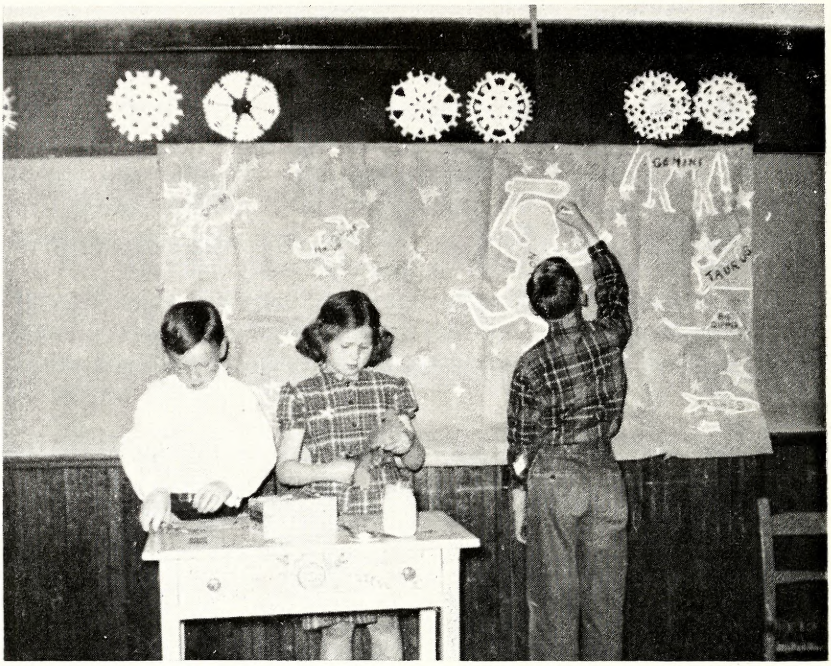
The children took account of the small amount of water they put into the vivarium, and the great amount of "rain" or moisture that collected on the top. The "rain" has caused many questions, too.

Example G. Problem: MAKING A SOLAR SYSTEM MODEL

The materials used were simple, and the cost was negligible.

One strong arm-piece was used to extend the whole system out from the wall about two feet. Each planet was suspended from an independent radius which made it possible for each one to move in its own orbit. These radii were merely thin strips of wood cut in varying lengths and mounted on a circular, wooden base (5 inches in diameter x ½ inch thick). These were anchored to the base by running a slender bolt through





Drawings and construction work while they were studying
STARS WE SEE

the base and through each and every one of the radii. The sun was symbolized by a large yellow balloon; the planets, by rubber balls secured at the dime store. The construction can be done for two or three dollars.

OBSERVING

The use of our natural tendency to observe is one of the ways that we help ourselves "to grow and know." To the teacher that tendency may be used as a technique of learning; but to the child it is mainly a happy experience.

There are levels in observing. Through one we see,

1. how things look.
2. how they act.

In a higher level we see and are concerned with what takes place, as in plants, animals and "things" that relate to

1. change and
2. interdependence

> Children need a lot of help in seeing change and interdependence.

The teacher's belief in the values to children of observations and *interpretations* sets the stage for what goes on as they live and work together.

A teacher of a second grade group remarked that if children are going to observe, they need to live in a "lush" classroom environment of new plants, of animals that are alive and other "things" *vital* to them. She had been watching the children stand on tiptoe to see everything in their classroom. She had listened as they talked. She went farther and offered three cautions: The "lushness" must be *NEW*, *ALIVE* and *VITAL* at that time.

> A problem study that deals mainly with identification of the things observed is inadequate.

Identification An eighth grade who studied minerals, rocks, and some specimens with semi-precious stones, yes, all they could find in their locality, did not stop with identification. They used books; they got help from the teacher. They did not stop there. For example, they found out the *change* that man made in the common minerals of feldspar, mica, kaolin and

quartz. They found out how it is produced, where and how it is used. They had the real product showing its use. They grew in their understanding and use of the word "function."

> The function is more important than identification.

The identification of a great number of things is not necessary; it is not even desirable. To identify fifty trees, or as many seashells, or many birds' nests or kinds of butterflies is a waste of time. With more than 400,000 insects in the world and the mass of plants, animals, rocks and minerals, one makes slow progress by the study of a single topic.

The child *does need to know* and identify those insects or bugs, for example, that are hostile to his plants and animals, such as:

1. the worm on the tobacco plant
2. insects on the tomato vines
3. an ant colony that runs to his house
4. mosquito larvae, wherever it is

And the teacher would plan for the child to have "firsthand" experiences in observing:
—the weathering of rocks
—erosion of soil near him
—frog eggs in a pond
—rocks and minerals in his locality

> These are types he wants to be concerned about.

Through observations the child gets to know:

1. Some identification (how they look) but not enough to get "bogged down" in that one activity.
2. Some behavior (how they act) of plants, animals and "things," and to be aware of *some causes and effects.*
3. Some *change* in plants, and animal life; in physical conditions and chemical ways.
4. The *interdependence* of plant, animal, and human lives.
5. Through the best means available,—the conditions *beyond the earth.*

Purposeful observation is a powerful tool in interpreting conditions about us

6. How "man" in his own locality controls his environment —such as water power, minerals, and soil.
7. Others that the children will tell about.

> To be aware of *change* and *interdependence* is very important in interpreting the things of nature about us.

Chemical Change.

Teachers have found that it is better for children to leave the work in elements, compounds and chemical change to the upper elementary school. It is little value for the smaller children and middle grades, to "play with" this material. For them it is a spectacular type of activity. The children can find out what elements are. They can find some of them—especially iron—most anywhere. They can study their uses. They can observe examples of *change,* as *Observing Chemical Change.*

"Fill a test tube about one-fourth ful of sugar. Heat the sugar and see what happens. After the white sugar has turned black, let it cool and taste it. It will no longer taste sweet. A chemical change has taken place and a new material has been formed."[1]

"Pour vinegar on some baking soda and observe what hapens. Hold a match over the bubbles. (Producing carbon dioxide)"[2]

Illustrations of chemical change should be used only *when* it is needed as a part of a solution to a problem undertaken by the group. Experiments are made to help evolve principles and generalizations.

Examples of Careful Observation and Interpretation in Problem-solving.

Example A. Problem: SHOWING EARLY ROOT AND LEAF GROWTH IN PLANTS

1. It was easy to observe the leaf growth on tomato plants which had grown from seeds, then replanted in individual containers.
2. Grass seeds were sprinkled on a wet bath sponge, placed in a fish bowl containing water, and covered with a glass plate. The cover was removed when the tiny grass blades appeared.
3. A glass jar was lined with a wet paper towel and a small amount of water kept in the jar. Bean seeds were placed between the paper and the jar. It was then easy to observe both root and leaf growth.

4. One side of a wooden box was replaced with glass. The box was filled with rich soil and a variety of seeds planted near the glass so that both root and stem growth could be observed.
5. A sweet potato and a carrot both produced lovely plants when placed in water.
6. An onion sprouted in a glass of water with pebbles to hold it in place.
7. New plants were started from the leaves of the African violet by placing them in damp sand and keeping them moist.

   Some conclusions were:

   1. Plants reproduce their own kind by seeds, bulbs, and cuttings.
   2. Green plants must have sunlight to make their food from the air and from the earth.

Example B. Problem: HOW IS A BALANCE OF OXYGEN MAINTAINED FOR FISH?

Fish and two aquariums were brought to the classroom. Several fish were placed in the aquarium containing marine vegetation; other fish were placed in the aquarium which contained only water. The children observed that the fish placed in the water without plants died and that the fish placed in the water with the plants lived. Generalization: Green plants maintain a balance of oxygen for aquatic animals.

Example C. Problem: TO FIND OUT MORE ABOUT THE FORMATION OF THE EARTH BY A STUDY OF ROCK FORMATIONS

Collecting specimens, discussion, using authorities.

In the unit on the structure of the earth, the class used and added to the otherwise large collections of rock formations. They classified them according to types. Some of these were found on the school campus. Some private collections and some individual week-end excursions swelled the samples.

The ways of working were:

1. examining the new samples.
2. going to sources for information.
3. adding the best ones to our collection.
4. holding class discussions on the new information on the subject.
5. using films.

This unit expanded into studies of the formation of mountains, of erosion, of conservation, of volcanoes, and of the

period of the earth's growth. Such a unit really never ends, that is, if some interest in it lives on.

Example D. Problem: How Do Frogs Develop?

We set up a simple aquarium in the school room. We got frog eggs and some plants from a nearby pond. With naked eye and with lenses we observed the embryos within the eggs by spooning out the eggs daily onto glass slides and observing changes.

One Monday we discovered several tiny tadpoles swimming about in the aquarium. There they were, but no one had seen them emerge from the eggs. Next day there were more lively tadpoles and fewer embryos.

Now we are watching tadpoles grow. We are finding that there must be proper balance between animal life and plant life. More questions came crowding. Books, authorities, and further observations will furnish answers. What do tadpoles eat? How long will they be tadpoles? How do they breathe? What changes does a tadpole undergo to become a frog? What do frogs eat? How do they get their food? Can frogs live in an aquarium? Why not? What is an amphibious animal? What changes can be seen from month to month?

Some frogs require two or three years to complete their change, most of them change within a year.

References.

1. Blough and Huggett. *Elementary School Science and How To Teach It.* Dryden Press. N. Y. 1951. p. 344.
2. Ibid.

COLLECTING

Children collect:

. in response to a need or suggestion.
. because many seem to have natural instinct for this type of activity.

Through teacher-pupil planning the children can find locally much of the material and the specimens that they need. The *purposes* of their collections should be very clear. They need to plan towards *what* to bring, *who* will do it, *why*, and *how much* of each item.

When it is decided by the groups, or when the teacher says "we need" or "please bring," some children come laden. They bring books, pictures, specimens, experiment materials, enough to cover shelves, tables and work spaces. And that is good to a degree. But when a child makes a collection for a special purpose, he has the right to expect that his contribution will be considered. If "collecting" is well planned, it is an excellent experience in sharing, in any grade.

> Plans for collecting materials and plans for using them help to insure more effective use of the materials collected.

The teacher and children will know *through planning*, the types of materials the children can bring; the teacher will know which ones she *must* have available. If iron filings will be needed and they are miles away, the school would need to have them there in advance.

1. The children can collect certain materials.
2. The teacher must know in advance what she needs.
3. The school should have a basic supply of unattainable items on hand.

Collecting and ownership motivate boys and girls to bring many things to school. The teachers cannot direct the science program around and "out of" this "mass" of casual collections. But they can have *plan* for using them—a table to put them on, science resource books, and pamphlets and free use of science books, and a little time to talk about one when a child just cannot wait any longer to tell his story; the upper grades may call this a *report*.

A fifth grade group had made this plan. The specimens (objects) brought in, which were not directly on an on-going problem, were put in a "mystery" box. When the child, or other ones were ready to tell about it, it was put on display. That did not take the place of a regular problem going on. It supplemented other activities.

If a classroom group has been burdened with a mass of seashells, old birds' nests, large boxes of growing plants, mounted butterflies, and a conglomerate of any other materials not needed in the solution of an immediate problem, they could well evaluate together to consider (1) what is its use (2) how to dispose of the useless.

> A mass of dead objects, or dust laden specimens take space and hamper the children's progress in science. It gives them a misconception of what "vital" collections are.

A Caution on Seasonal Study and Repetition

Seasonal collections, such as seeds in autumn, butterflies in the spring, birds' nests in the winter and seashells following vacation, may *retard* real science study and work. For example, if children study "How seeds are scattered," in one grade, (it is usually about grade three), and make collections of them, it is a waste of their time to do the same type of thing in the other grades. If seeds, for example, are studied in a higher grade, the content should be on a higher level. In the upper grades children may study "ways in which seeds are tested in our State laboratory," as an aid to all persons who use seeds.

Example A. Problem: THE MAKING OF PAPER AND ITS USES

During our unit on paper making, the children collected types of materials that man had used to preserve records before paper was invented. They collected stones, sharp sticks, the hammer and chisel to represent the cave man; clay tablets for the Babylonians; silk for the Chinese; and cotton and linen rags for the Arabs. Others were: Bones, leaves of trees, pieces of bark, leather, metal, and tablets of wood covered with wax.

Later in the study they made other collections to show the different materials *used today* to make paper. They secured flax from California, linen rags, old newspapers, straw, cornstalks and grass. Among the woods collected were the spruce, fir,

pine, cedar, elm, beech, poplar, chestnut, cherry, and oak. Clay, rosin, dyes, and starch were secured, since they are used in paper making.

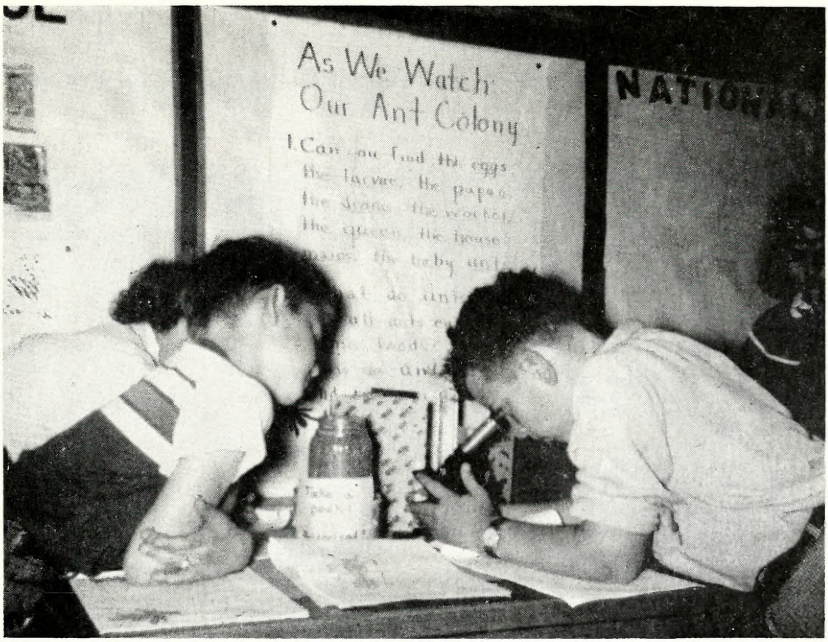
The last collection was a group of paper-made items that are important in our everyday lives. These included writing papers, printing paper, newsprint, absorbent papers, pasteboard, tissues, building papers, wrapping papers, paper bags, paper cups, plates, spoons and others too numerous to list.

They enjoyed the story of early man watching the hornet chew the wood into pulp and spread the pulp in a thin layer to dry.

Example B. Problem: MAKING WAY FOR AN ANT COLONY IN OUR ROOM

The group was studying insects in our gardens, and about us, when the ant colony idea came out. Everyone agreed that an ant colony could be found nearby, but necessary equipment for bringing and keeping ants in the classroom had to be found.

A rectangular box, 9 inches wide, 16 inches high and 1½ inches deep, was made. A strip of molding was attached to the front of the box for a feeding trough. Legs 1½ inches long were placed at each corner and the box was put in a tray which had 1 inch of water in it.



The class group found a hill in which the colony seemed to be very busy at work. They were careful to get eggs as well as ants. Dirt, ants and eggs were put in the box which was then covered with glass and black paper. Food was placed in the trough. Several days passed. We lifted the black paper and found, by looking through the glass, that the ants were very busy building their rooms, tunnels, and setting up housekeeping anew in their new home in our classroom.

Example C. Problem: SEEDS ABOUT US, HOW THEY TRAVEL

The pupils brought in a great many milk weed pods those fall days. They found the plumes on the seeds and blew some of them to see how they traveled in the wind.

They began bringing many kinds of seeds to identify and also to see how they traveled. Interest in collecting, reading, and discussing seeds was high. They used nature handbooks, the encyclopedia, many science texts and many library books for pictures and information. Some pupils made drawings to illustrate some of the ways seeds travel. But best of all were the seeds themselves.

Caption: Careful attention should be given to what is done to vitalize teaching. Animals in a room, an aquarium, rock and soil collections or growing plants may not indicate science teaching. Science is evolved when there is interpretation in terms of universal principles.[1]

1. Craig, Gerald S. *Science For the Elementary School Teacher.* Ginn. 1947.

CONSULTING AUTHORITIES

Do you ever invite an authority to come to your classroom? Do you go to visit an "authority in his work?"

Science Authorities We consider that science authorities have used a lot of time, effort and intelligence in studying a subject. Some of them have spent a lifetime in research work, trying to find out more and more for us. Some who have not done research themselves know what others have done. Some scientists have written books; some have not. *No real science authority claims to know everything.*

> We consult authorities because of their knowledge on what we want to know.
> We should respect them.

Suppositions and Hypotheses Children like to give their own opinion and beliefs. like to express an assumption that seems likely to them to be a true explanation of things. Some teachers often use that technique. Children need to be asked more often, "What do *you* think—was the cause, the effect, or what will happen?"

> The child's reasoning should be respected.
> Never laugh at him.

There are certain types of answers that children can find for themselves.

"How fast do you think the plant will grow?" (Measure one.)

"How do you think aphid type insects get their food?" (Observe this type.)

"How do you think we can destroy household pests, chewing and sucking insects?" (Search for facts in texts.)

For other types of answers, children *must* go to authorities:

"How far is it to the moon?"

"How does a green plant produce food?" (Scientists do not know yet.)

"What do the microscopic organisms that live on the skin rather than the body look like—such as: ring-worm, athlete's foot, impetigo, boils?" (Consult books, slides and pictures made by authorities.)

There is a place for children's hypotheses.
There are questions that we must look to scientists to answer for us.
We save children's time when we know one from the other.

Using Local Authorities A person may not be an expert in science but by his interests, experience, work, study and travel he knows a great deal that the classroom group wants to know. So they invite him.

—The father of a fifth grade boy came to the classroom to tell them "all I know," he said, about his own irrigation for fifteen years in the Columbia River Plateau in the State of Washington.

—A supervisor in a textile plant explained to a small group of boys and girls some of the processes used to make rayon goods. The group, in turn, reported to the class.

—A seventh grade group made a special investigation of "dacron" the first week the first bale was manufactured in their city. The local authorities were the fathers who worked in the plant.

—A sixth grade group went to see "firsthand" how thread was made.

—Some observance of radioactive and florescent minerals was a very real experience to the seventh and eighth grade group who add to their school's rock and mineral collection each year. They visited Mr. ————————'s collection in the village, saw his luminous dark room and "drank in" what he had to say.

—A good farmer, who had both training and practice, came to school to talk to a third grade on how he "saves and builds" the soil.

—Many grades visited a furniture making factory to see a movie "from tree to chair" and to see the uses made of wood.

Forces in Nature What better authorities can there be than:

. to see a chick break through its shell?
. to watch the bursting seed as it swells and grows?
. to see the power of water at work?
. to see chemical changes demonstrated by man?
. to watch heavenly bodies through powerful telescopes?

In consulting authorities, children learn through:

Persons.
Books (Writing).
Authentic visual aids.
The forces of nature.
Forces made by man.

Examples of the Use of Authorities in Problem-solving as One of the Ways of Learning.

Example A. Problem: A PLANT IN OUR COMMUNITY—IDENTIFICATION

"THE STORY OF THE PENNYWORT"

In Room 8 you will find a cracked jar full of a plant called "Pennywort." It is planted in the soil from the ditch where it was found. It is sealed with cellophane and scotch tape. The jar label says 9/6/50.

The class of 1950 did not think that the plant could live without adding water. They had sealed it, as it is, and put it in our science corner, not completely out of the sun. Instead of dying as they thought, the plant began to turn a deeper green and began to grow. They did not water it but the plant was never without moisture. They found that this condensation carried on in the jar gave the plant the necessary amount of water that it needed to keep it living. They also concluded, right or wrong, that the crack in the jar must have given the plant some air.

During each vacation the jar was placed in the shade; on our return to school, the leaves had turned brown. The first year they thought it was dead, but they decided to keep it because it was pretty even though it did look dead. *The dust was wiped from the jar and then placed in our science corner again.* You can imagine the surprise of the class when the plant began to turn green again the first time.

It had been with us three years—that cracked jar and the "Pennywort" when the present class in Room 8 decided to find out its real name.

They began by asking the people around them—parents, teachers, farm agents and friends. Some said, "I do not know what it is." Others gave it various names. The class was never quite sure. The idea that the class might write for help to the Botany Department, North Carolina State College, Raleigh, was fruitful. The inquiry gave the history of the plant to date, and also included a specimen.

Their reply came, it said:

"The name of your ditch plant is the common 'PENNYWORT.' It gets its name from the round penny shaped leaves. It belongs to the same family as the wild carrot. It grows where the soil is kept very damp, or even wet. Ditch banks and ponds' edges seem to be the favorite homes for the Pennywort."

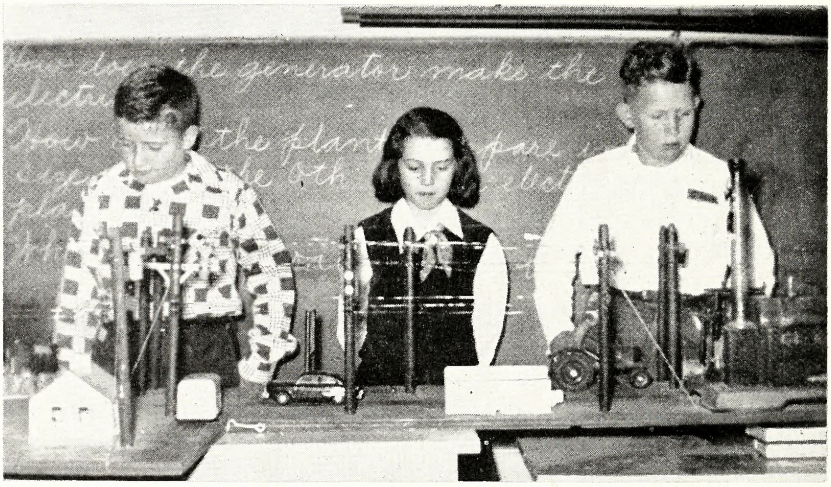
I know that the class cannot go far by the study of one plant. But our own "Pennywort" on our ditch was different.

Example B. Problem: OUR HELPER, ELECTRICITY, HOW IT WORKS

We learned a lot about electricity from books and from our experiences. So we invited the local representative of our power company to come to us. He brought a small model of a steam-electric plant, showing the large transmission lines, the substation, and the service lines. We fired the little furnace which heated the water that made the steam. The steam furnished the power for the turbine which turned the tiny generator that produced a small amount of electricity. He told us that the electricity to light our homes and run our appliances is generated in a steam-electric plant.

Example C. Problem: HOW TO PREPARE THE SOIL FOR OUR SCHOOL FLOWER GARDENS

Our school ground has a lake with very damp, hard soil around the edge. That made a problem in plant selection and soil preparation. We collected soil samples and talked about



One of the ways we learned about electricity

what we could do to get the soil ready for planting. Some members suggested that we contact the county farm agent. He came and answered some of our questions and told us how to have the soil analyzed at the State Laboratory. When the report came back, he gave us advice on how to figure the amount of fertilizer needed and when and how it should be used.

An employee at the seed store was helpful, too. He talked with us about the proper time and method of planting. He shared with us a letter that he had received from the bulb grower in Holland from whom he has been buying bulbs for a number of years. And more, he generously shared with us some flowers from his own yard.

Example D. Problem: HOW DOES THE ELECTRIC LIGHT METER WORK?

"When the man comes to read our meter, how does he know what to charge us?" The class chose a committee to visit the power and light company office to invite the manager to come to our classroom to talk to us about this.

These gardens are just in the making

He came the *following* day and brought a light meter. He taught us how to read the meter, explained about a kilowatt hour and taught us how to work out the cost per kilowatt hour. He suggested that we keep a record of meter-reading in our lunchroom for one week, checking the hours used each day. By the end of the week, we were computing electrical bills from the meter readings.

The text helped, the teacher did, too. The teacher must have credit for planning all this.

Example E. Problem: SOIL CONSERVATION

A study of soil conservation caused us to study our nearby Leonard Creek *Watershed.* Our main plans were to observe samples of the soil, subsoil, and topsoil. We also looked into soil erosion, erosion control, contour farming, and improved pastures.

In addition, the committee leader of this project stimulated the group to work and to accept responsibilities.

Example F. Problem: PLANT AND ANIMAL LIFE RELICS

On the edge of our rural school ground we found a petrified muscle. It laid on our science table almost unnoticed. Then, one day a boy brought in a beautiful object that was highly polished

The teacher was right there and took the notes for our follow-up discussions

and several shades of brown. Our books did not help us identify it, and we were not satisfied with guesses. The class wrote to the State Museum, enclosing the object, and asked their help. The answer was amazing to us. It was a shark's tooth, the type being extinct now, but which did exist thousands of years ago when the Atlantic ocean covered this area, which is now about sixty-five miles from the present shore line.

Example G. Problem: ROCKS AND MINERALS OF THIS AREA

While studying "Rocks and Minerals of Our Area" an eighth grade class used specialists in that work. A chemist and a geologist from a feldspar grinding plant helped to identify their specimens, both in the classroom and in the field. Near the end of the study, a geologist with the U. S. Geological Survey accepted their invitation to visit the class. He showed colored slides of geological aspects of the nearby area and answered numerous questions including this one, "How can some of us become geologists?"

Example H. Problem: PROPER FERTILIZER FOR OUR SCHOOL GROUND GRASS

The school planned to sow the lawn in grass and a local man had offered to give the necessary lime and fertilizer. "Why will lime be used?" "What kind of fertilizer will be used?"; "What does 5-10-5 fertilizer mean?" "My daddy uses 4-8-4 fertilizer for tobacco and Diane's father uses 5-6-10. Why?"

We sent soil samples of our school ground to the Experiment Station. By return mail we received the recommendations for the use of fertilizers. This tied in with a unit in our science book; it required library work, and led to discussions of improvment of soil in our area. Pictures and clippings were easily available.

This was an excellent chance for outside speakers such as the farm agent and the agriculture teacher.

FIELD TRIPS

A field trip is another way to learn by "purposeful" doing.

The trip should be so planned that children go for certain purposes and confine their activities to those purposes. If they do not and children run "helter-skelter" into everything they might see, it will be most difficult for the teacher and a waste of time for the children.

There are insects, flowers, trees, plants, conditions of soil, erosion, sky, stars, constellations, seeds, minerals, reproduction, interdependence, physical change, and chemical products about us that the child needs help to see and interpret according to his need.

Field trips can be valuable for both teacher and children if:

—the purpose for going is worth their time.
—every child knows *why* he is going.
—every child has some questions that he will be responsible for.
—there is careful previous teacher-pupil planning.
—there is group planning.
—the child goes with responsibilities in mind.
—there are sincere attitudes; field trips are not "just for fun."
—the child is growing in observing.
—the child learns to report more accurately.
—the trip extends the child's interests.
—the trip extends his knowledge and understanding.

Nearby Trips If the specimens that are being studied are within easy walking distance of the classroom, planned trips to study them "in their own home" can be made often. It does not take long. One sixth grade went down the hill less than one quarter of a mile to see destructive erosion.

Some schools are making "nature trails" on their school ground. Along these trails there is much to study, for example, interdependence of animal and plant life, balances in nature, variety, and adaptation.

Trips Farther Away If the specimen, objects, or place of interest is farther away and transportation is necessary, there must be:

1. planning with the principal of the school.
2. group planning of duties.
3. parent consent.
4. time allowance.

> A trip too hurried and too much undertaken does little for anyone.

Teacher Preparation

1. Plan with the person who will be responsible at the place or plant that you will visit.
2. Know from a visit himself or from literature what the children will see.
3. Know from a visit where to find the specimen.
4. Do not attempt too much at one time.
5. Work on visitation "manners" with the children. The place you visit will recall their "manners" long after they have gone.
6. Remember the place you visit—the mine, the pond, the textile plant or museum is "somebody's home." The children should not take liberties.
7. The children should not expect favors.
8. Do not stay too long.

Field trips are one of the ways to learn.
The real specimen or object is the most valuable visual aid—we must not mutilate nor destroy scarce specimens.
Field trips must be made for a special purpose.

Experiences From Field Trips Used in Problem-solving.

Example A. Problem: SHARING LANGUAGE ARTS IN SCIENCE.

Story Following a Field Trip:

When we went on a field trip, we saw many interesting things:

We found a lot of good things for our science table. David caught a big grasshopper. We saw a butterfly but we could not catch it.
Loyd caught a gold bug on a tree.
Jerry found a doodle bug.
We saw many kinds of trees. We are learning some of their names. We brought leaves to our room.
We found some pretty rocks. We like the"snuff box" and the oak ball.
Something funny happened. When Judy bumped into a tree, she said, "Excuse me, please."

A first grader "looks at" the caterpillar tent
(under safe supervision)

Example B. Topic: How Plants Grow

The purpose of our field trip was to get young plants to observe in the classroom in their day-by-day growth. From a discussion we were prepared for our trip:

1. *What To Find.*
   We wanted wild flower plants for our garden in the classroom.

2. *Where To Go.*
   The plants we wanted were near the school grounds.

3. *What To Take.*
   It was necessary to take some boxes or cans, spades, and buckets in which to put the soil.

4. *How We Went.*
   We were near enough to make our trip "on foot", besides it was fun walking there.

5. *What We Found Out.*
   In the search we saw many different plants in kinds and sizes. Some were growing in open spaces and some in places that were crowded; some had flowers and some did not have flowers. Some plants were larger than others. We also saw the color and different kinds of soil. All of us saw some larger plants growing in dark soil, and some smaller ones growing in light sandy soil.

6. *What We Got.*
   We tried to collect the plants without harming the roots and to leave plenty of soil around the roots. We brought samples of the different colored soil we found to the classroom. We were successful in finding plants, too.

Example C. Problem: PRODUCTION AND USES OF OUR NATIVE GRANITE.

The quarry is located just outside of our town. Yet the study by this seventh grade class on rock formations would have been much less real without the visit to the granite quarry, said to be one of the largest of its kind. (Arrangements were made with the company officials for the visit and with parents for transportation.) These children were familiar with the quarry, in a vague sort of way, but they had no real idea of how the rock was quarried, the vast extent of the deposit downward, nor of its many uses.

The trip to the site of the quarrying was followed by another to a local monument company where tombstones were made and sold.

Example D. Problem: A STUDY OF BIRDS.

There were several robins hopping about in our schoolyard that spring. From this we planned a field trip nearby.

There was much planning and sharing. A few simple rules were made:

We should walk, not run.
We should not go ahead of the leader.
We should talk or laugh softly.
We should look for wild plants, insects, animals.
We should stand still at times and just listen.
We saw a few birds that day.

Example E. Problem: HOW OUR SCHOOL FURNACE WORKS.

On a trip to the furnace room of the school a child in the group was attracted by a large wheel turning. A wide belt went around the wheel and onto another smaller wheel. "What do these wheels do?" "Why are they there?"

The trip was concluded above ground where the janitor pulled up the clinkers from below by using a pulley to help him with the heavy load.

The second grade children found out that wheels helped people. Wheels move faster than one can walk and they will move a heavy load easier than one can carry it.

Example F. Problem: CONSERVING OUR FOREST.

Continuing our study on conservation, we made field trips to know about:

1. different diseases of trees nearby and the treatment needed.
2. the different layers of trees.
3. how one can tell the age of a tree.

4. ways of thinning our forest.
5. methods to use in the prevention of forest fires.

References.

1. Pitluga, Geo. E. *Science Excursions into the Community.* 1943. Teachers College, Columbia University, N. Y.
2. Blough and Huggett. *Methods and Activities in Elementary Science.* 1951. Dryden Press. p. 34-35.

EVALUATING

Teachers Evaluate

So much depends upon the teacher's skill in estimating values and worth. She is the only person in the class who has the complete overview of both curriculum and methods.

Evaluating devices and activities are often used to give the teacher and the children a measure of the children's achievement. *The achievement should always be interpreted in relation to the device used.* How the teacher values the experiences she has offered the children, or her own success, is important, too. Activities designed for evaluating often prove extremely useful as learning activities.

The teacher estimates the value of:

—a particular topic for study at a given time.

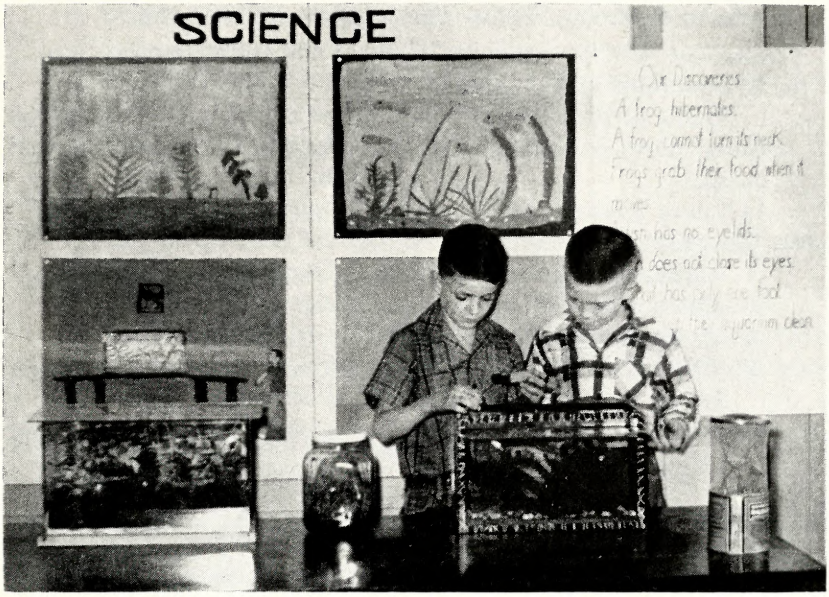
—the types of activities to promote.

—the best methods and materials to use.
—the type of testing procedures; the tests to make and use.
—the growth of boys and girls in scientfic attitudes and information.
—the classroom lessons he teaches.

> "No matter how well all the preliminary planning is done, science dies on the vine unless classroom lessons are good." [1]

Children Can Evaluate, Too. If we give children a chance to say what they think and why they think so, they will have a lot to tell us. Watch how they "dig into" a job. Listen to what children have to say. They can tell when:

—teacher-pupil planning is genuine.
—the problem is worth their time.
—the materials are suitable.
—their group work is well done.
—they are interested.
—each child is a participant.
—they accomplished what they started out to do.



Children are good helpers in evaluating science activities.

Examples of Evaluating Experiences in Problem-solving.

Example A. Problem: GETTING SCIENCE FACTS OUT OF AN AQUARIUM AND TERRARIUM

The fourth grade students "took turns" in observing closely their projects,—an aquarium, and a terrarium containing plants of several different varieties. Some of the things they found in books and some by observing and comparing with others experiences:

1. gold fish grow very slowly in an aquarium; they grow faster in an outdoor pool.
2. a fish does not close its eyes; it has no eyelids.
3. a fish does not swallow the water that goes into its mouth.
4. fish cannot live without air; it has gills instead of lungs for breathing.
5. there are many different colors of gold fish.
6. some snails hatch from eggs, some are born alive.
7. snails help to purify the water in the aquarium.
8. plants must have air, water and sunlight.
9. some plants have blooms, others do not.

Example B. Problem: USING ELECTRICAL APPLIANCES.

Evaluation of this unit was made in the following ways:

I. By reactions of the pupils.

"Some of these things I had heard about but we discussed them more. I learned a lot more about them and enjoyed them."

"I found answers to many of the questions that I asked."

II. Teacher evaluation:

1. Children learned to do simple repairs to wires and appliances.
2. Class discussion was free.
3. Children did simple research on their own through books and through people.
4. Children showed interest by assembling materials and their follow-up work.

Example C. Problem: THE USES OF ROCKS AND MINERALS OF THIS AREA.

At certain times during the study, the class took some time to review what had been done satisfactorily and what remained to be done. The teacher and pupils, working together as they did in frequent planning periods, used these questions to guide the evaluative process:

1. How many questions asked at the beginning of the study have been answered? Which questions have not been answered to them?
2. How many types of specimens are now in our collection? Can we discuss them intelligently? Do we need more authoritative help in identification? Which books have been valuable?

   Do we need other reading material?
3. What information have we selected for our permanent record? What other information do we need to write or illustrate? Which committees have reported? When will others report? Which individual projects are complete? Which activities have proved most valuable? What are our next steps?

Example D. Problem: HOW SEEDS TRAVEL.

In evaluating our study of seeds and how they travel we found that as a group we:

1. had many pleasant trips in the cool autumn weather collecting specimens.

2. learned to know many plants and trees that are right around us.
3. understood more of how trees and plants can scatter their seed.
4. learned to use more library books and encyclopedias in addition to our text.
5. had practice in committee work.
6. had practice in arranging our information and specimens.
7. must listen closely when someone is reporting.
8. must not plan many reports for one time next time.
9. needed to use good spoken English when we invited the other fourth grades in to see our bulletin board and hear our talks on "Seed Travels."

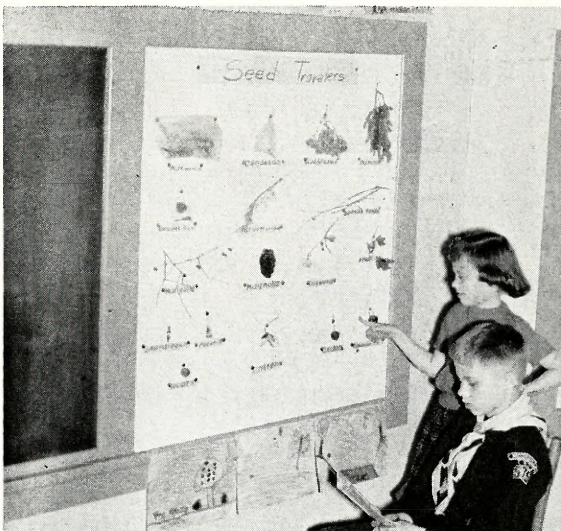
Example E. Problem: THE SUN'S FAMILY.

A Teacher Evaluates,

I consider that the children have spent their time to advantage in this unit on the Sun's Family—the planets. They have planned together, shared experiences and widened their information. Concepts have also been extended by reading what the Greek fathers thought of the stars and planets. The children related their experiences to life by being aware of man's use of the modern ways in everyday life. In this unit plan we have also been aware of English, reading, art, spelling, and the social studies in these few weeks.

Reference.

1. Blough and Huggett. *Methods and Activities in the Elementary School.* Dryden Press. N. Y. 1951. p. 86.



USING LIBRARY MATERIALS

The Need

In seeking to satisfy curiosity about scientific information it is necessary for boys and girls to have available books in the science field and to know how to use these effectively. Schools have a responsibility both to provide the materials and to give instruction in their use.

The Approach

In the past many books which contained science information were written as fantasy rather than as facts. Today's library of science books must provide a large collection of titles which approach science in a scientific manner. Through the use of many library books children are helped in the development of their scientific thinking.

> Learning to distinguish between fact and fantasy in books encourages critical thinking and evaluation.

The School Library

In order to provide a representative collection of science books on many reading levels, to be used by all the boys and girls in the school, it is necessary for the science books to be a part of the school library.

> The school library provides science books for boys and girls which are related to the science curriculum.

Examples In Using Library Materials.

Example A. Topic: THE SUN'S FAMILY

An article in the local newspaper telling about an expected eclipse of the moon came while the sixth grade class was working on one of its developmental units in Science, *The Sun's Family.* Causes of eclipses were very real to these boys and girls. The entire class began to search for causes. Many sources of materials were used. One group used the pamphlet, *The Solar System,* another used the texts. The boys and girls used encyclopedias, library books, and many materials indexed in Rue's *Subject Index to Readers.*

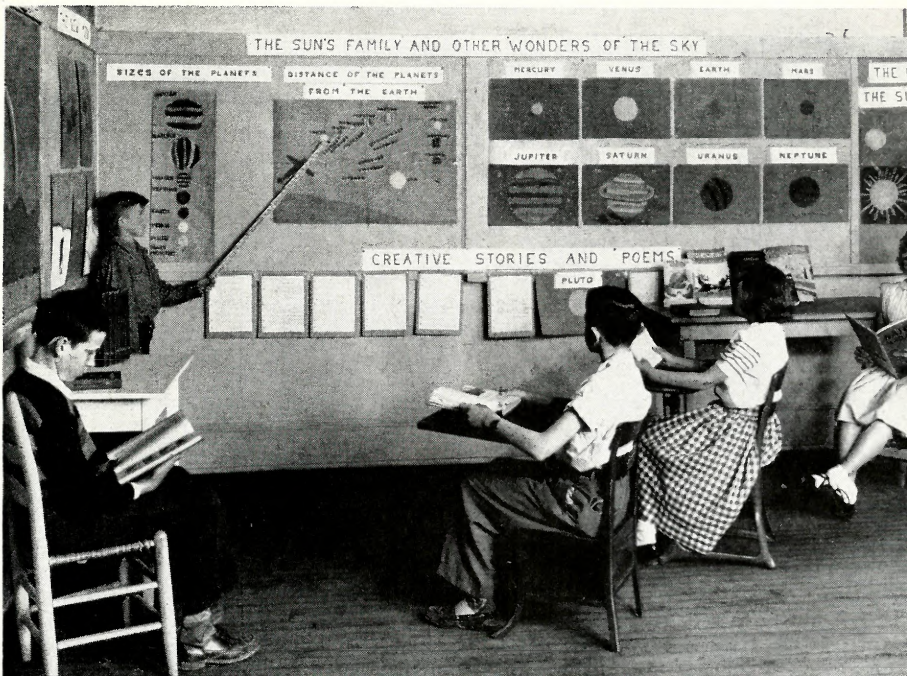
One group used *The Golden Nature Guide On The Stars;*

another group read how to make a chart showing the relative sizes of the planets, and relative distances from the earth. *Trailways* Magazine articles concerning Observatories and Planetariums, also articles about the Morehead Planetarium, at Chapel Hill, which some had visited, were used. "The Science News Letter" gave sky maps. The article on an expected eclipse stimulated more interests. How many planets were there anyway? What resemblance have they one to another? These were some of the questions.

There were opportunities to learn facts, but they could also learn that questions are solved to the extent that they use materials available that can help to answer them at that time. Later more can be learned.

Example B. Topic: PERMANENT MAGNETS AND ELECTROMAGNETS

The children had studied simple magnets and permanent magnets. But the word "electromagnets" in a text was a new term. Joan thought that she could explain from her reading how it was different from a permanent magnet. Lloyd was not satisfied with her explanation. "How," he asked, "can we find out more about electromagnets?" "Will there be anything about them in library books?", another asked. Five boys went to the library to see. They reported their findings and brought to the class some of the books on electromagnets and their work.



Example C. Topic: IDENTIFICATION: ARE THEY TERRAPINS OR TURTLES?

A pupil in our fourth grade found thirteen rubber-like eggs in the river low-grounds near his home. He placed them in a jar of warm dirt until they hatched. When the right day came, he brought three turtle-like animals to school. He called them terrapins. Some pupils questioned his statement. Many ideas were expressed.

To find the answer the pupils searched through the books in the school library, but they could not identify them to their satisfaction. When the answer was found, the name was "painted pond turtles."

We put these painted pond turtles in our "little museum." As an outgrowth of that study of the turtles, other animals were collected and more investigations of our pond life went on.

Example D. Topic: HOW SEEDS TRAVEL

In our study of how seeds travel, we first looked in Science textbooks for information. Our librarian helped us find books about seeds and their travels. Two books were entirely about the different ways seeds travel; we found chapters on the subject in other Science books. We took these books to our room to read. We discussed what we had found with the others in the class. After our reading and discussions, we made a classification of the ways seeds travel into these big headings: 1. By water, 2. By wind, 3. By sticking to animals and people, 4. By falling and rolling, 5. By birds, 6. By jet propulsion, or popping.

Some of the books we found most helpful were:

1. *Seeds and Seed Travels,* by Parker.
2. *Travelers All,* by Webber.
3. *Plants Round the Year,* by Blough and Parker.
4. *By the Roadside,* by Dunn and Troxell.
5. *Interesting Neighbors,* by Jenkins.

USING SUPPLEMENTARY TEXTS

State Text

The State of North Carolina has prescribed textbooks for Science instruction in grades I-VIII as it has in other subject areas. This text series, with the teacher's manual for each book, gives a developmental program throughout the grades.

Each teacher needs to know these texts; not just the one for one grade, but to have such acquaintance with those of the other grades so that the topics will be familiar. This acqutaintance will help in guiding the children in selection of topics and in the extent of their studies.

> Children will "plunge" beyond their expected understandings and leave the more simple ones untouched.

Other Texts

A principle of the scientific attitude, that we should search all available sources for the truth, makes it a "must" to have as many texts and as well chosen materials to use as possible.

The State approved supplementary texts for 1953-54 includes several series of texts—grades I-VIII (one I-VI). There are also a number of pamphlet source materials.

The children of each grade or section will profit by having in their own classroom at least one copy each of the five or more listed supplementary texts for ready reference.

USING AUDIO-VISUAL MATERIALS

Audio-visual materials are one of the tools of learning which teachers and children use to advantage.

Purposes

It is important that audio-visual material be used to help solve an on-going topic or problem. The class groups should turn to these aids just as they would to another book, an encyclopedia, or any source material.

> Audio-visual aids do not constitute a program of their own.

Types

Too often an audio-visual aid is interpreted to mean a machine, a projector, a film, a film-strip and a screen. That type has a place, but it does not constitute the whole audio-visual aids materials.

Types of Visual-aids That Can Be Used To Advantage Are:

—realia,—what one can see with the eye.
—pictures or flats in the texts.
—collected pictures from any reliable source.
—collected specimen—pertinent.
—phonograph recordings.
—tape and wire recordings.
—live objects—plant or animal.
—objects not alive—rocks, minerals, plastomounts.
—black and white or colored slides.
—film-strips and films.

> The film and film-strip has a place, but not the whole place in audio-visual aids.

Use of Audio-visual Aids

In the best use of the ten aids above, *let us be sure that:*

1. there is a REASON for the use of the aids selected.
2. there is VARIETY in the types of visual-aids in the program.
3. the "movie is not the chief activity.
4. an assortment of grades do not "look on" because a film or film-strip is being used by another grade or section.
5. there is preparation for use and follow-up.
6. the picture is shown more than once during the problem if the children are expected to get the details.

Examples in Selecting Materials

Few schools have all of these ten types of aids that they want. It is a matter of wise, *co-operative choosing*. It is a continual process.

I. A representative teacher from each seventh grade in a county unit worked together on audio-visual aids: "What Basis Shall We Use for Topical Selection in Audio-Visual Aids Types?", was considered.
From that they considered each "big topic" in the curriculum guide and the text first. They chose to work towards a variety of aids on the topics, selecting first the ones the teachers felt would help to make the subject "clearer" to the children.

II. The teachers and children of another school worked consistently collecting pertinent flats (pictures) on the developmental topics for each grade. The class evaluated the flats, rewrote the captions in their own words, and mounted and filed them in their central library. They are adding to their list of 69 selected the first year.

III. Another school worked on a school museum. Since museums can become "junky", "musty" and conglomerate, the evaluation of the worthwhileness of a specimen was rather high.

> Labeling, proper display, *variety,* worthwhileness and use should be key words in a school museum collection.

With care in selection, each school can have helpful materials of a museum type. *Should a child in an eastern county wait for years to see a specimen of mica, or conversely, in a western county, should a child wait to see a star fish?* Other products, as cotton, are exchangeable.

Fresh, vigorous topics require fresh, vigorous specimens. Take a trip to the school museum. Borrow a specimen; use it; return it.

> No classroom should look like a museum.

Use of Filmstrips and Films

The film or film-strip should not be a complete "meal" for one class period or lesson. With children in the primary grades, the exposure should be for only a fractional part of the class period. Even in the upper grades the teacher will often find it advantageous to show only the parts of the film-strip that she wants the children to get understandings from at that time. When it is shown for factual details, repeats are necessary. That would be true also of recordings where there are several subjects on one record.

In using projection slides and the film-strip, the teacher can select the slides or frames that will be particularly pertinent for factual details to the class. That type of use has proven exceptionally helpful. At other times it may be desirable to show the whole strip. Beware of using too much "movie" at one time.

Preparation for using a film or film-strip means:

—previewing by the teacher.

—at times the selections of the frames to use at that time.
—preparation of the children.
—follow-up by the teacher and children.

> It is often helpful to show selected parts of a filmstrip that are particularly pertinent to the subject.

Examples in the Use of Audio-visual Materials.

Example A. Topic: HOW SEEDS GROW.

In the study on how seeds grow, the children saw how seeds look in the ground before they send shoots up that can be seen.

We watched the seeds get larger and the outside coats open and tiny roots and plants come out. Little roots and a stem grew on each plant. In two or three days leaves grew on each stem. The thick white part of the bean turned green and finally fell off. Each stage of growth was watched with interest.

Example B. Problem: ELECTRICITY AND HOW OUR POWER PLANT WORKS

Towards the end of our study of electricity, we borrowed slides from our Power and Light Company for use in our classroom projector. The slides traced the electricity from the

Cape Fear plants through sub-stations and transformers to our homes. The slides also gave facts about the cost of operation. We saw, next, "Summer Storms," a film from Westinghouse, which emphasized the care taken at sub-stations to insure continuous current during storms. We were interested in the workers who make our electricity possible, as well as an understanding of how power plants work. This was a "little problem" in our big one.

Example C. Topic: MAKING PROJECTION SLIDES.

We needed a permanent way to keep some information on subjects in Science for future use. And the sixth grade wanted to learn how to make projector slides. It required reading directions, close observation of specimens, and books on content. They had fun, also, drawing on glass, coloring, taping, and discussing. Since our slide material was limited, the class was very careful in selecting topics to use.

The completed set of slides showed that tadpoles developed into frogs. The children wrote introductions for the slides.

References.

Kinder, James S. *Audio-Visual*—Materials and Techniques. American. N. Y. 1950.

Dale, Edgar. *Audio-Visual Materials in Teaching.* The Dryden Press, 386 Fourth St., N. Y. 1946.

The North Carolina Audio-Visualist. Quarterly Pub. of State Association. May Boone Cape, Red Springs, N. C.

Educational Screen. 64 East Lake Street, Chicago.

Handbook for Elementary and Secondary Schools. State Dept. of Public Instruction. Raleigh, 1953.

USING CREATIVE EXPRESSION

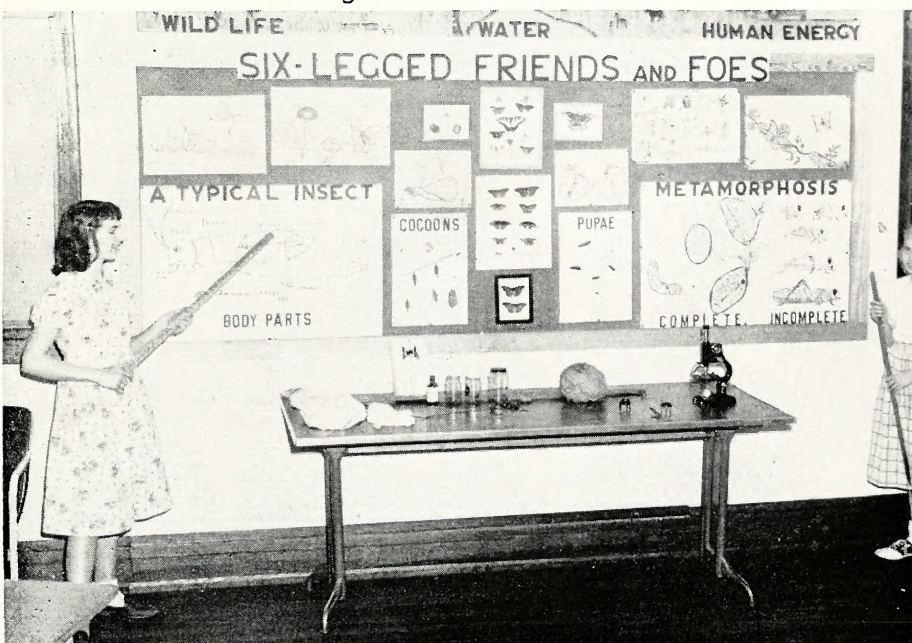
Almost any media used in creative expression will have a place in making science "come to life" in the science program. It provides another way of learning by doing. Creative activities and science learnings can be on-going partners. There is a caution.

> The idea expressed and the science concepts should be primary, not the product itself.

Types

This bulletin calls attention to many types of creative work. This section is more concerned with representation by drawing and sketching. Either the child or the teacher can do "quick" drawings, on the board, a chart, or slide. This activity can show groups of, as "Six Legged Friends and Foes;" common likenesses; and metamorphoses.

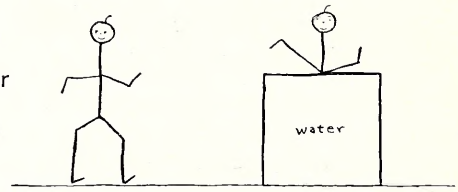
Creative drawings concerned with CHANGE



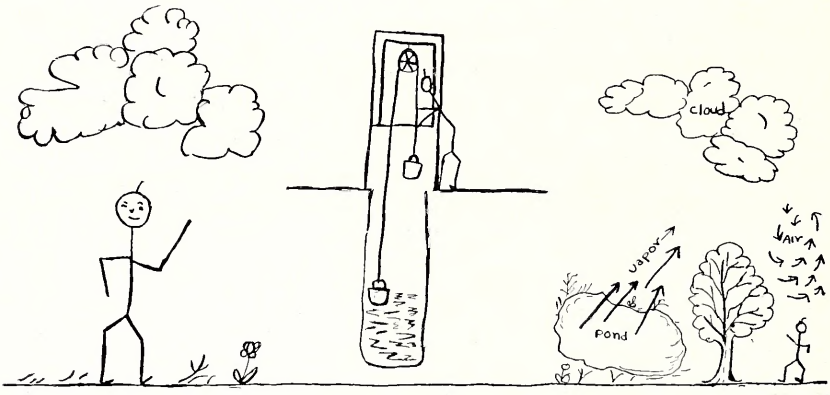
Place

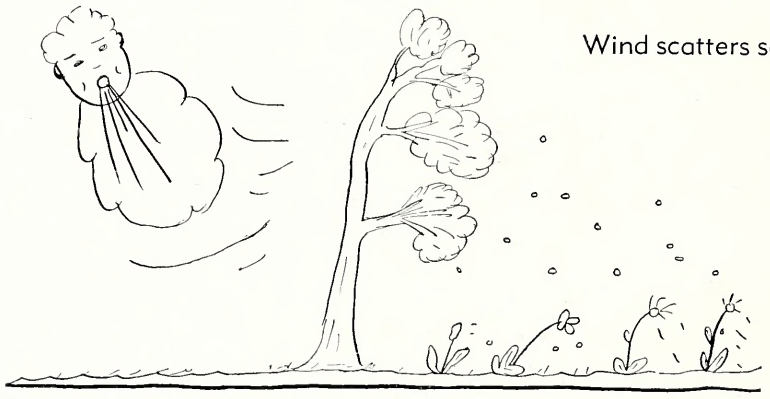
Beware: *Meticulous drawings of the parts of a flower or the parts of an insect* for emphasis or memory work *about that one insect or plant* has little place in the program. Science must deal with problems, generalizations, principles, and such big ideas as CHANGE, VARIETY and ADAPTATION.

More than half of you is water

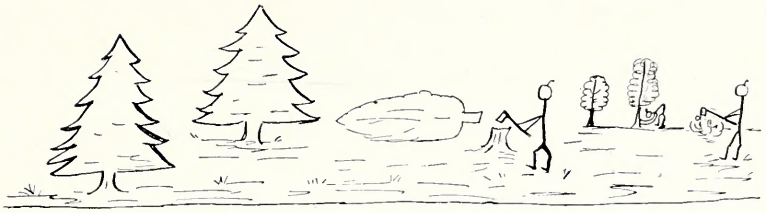


Water is above you — Below you — Around you



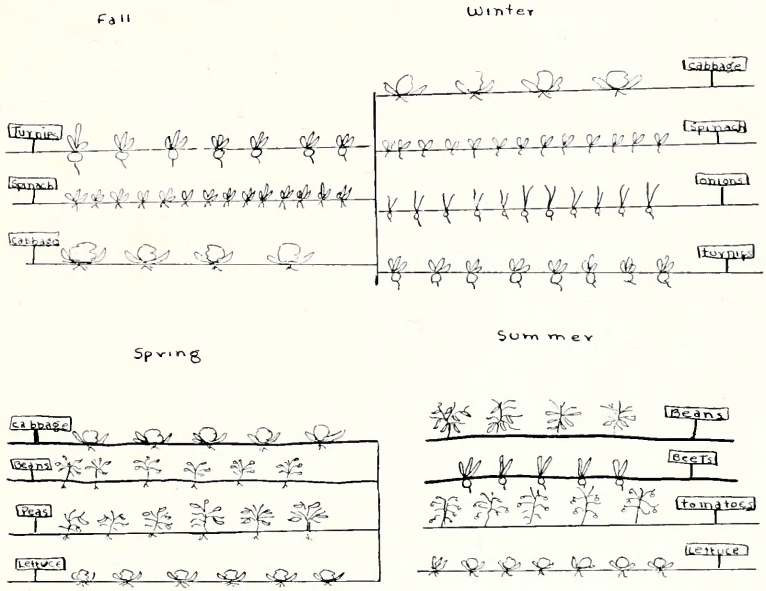


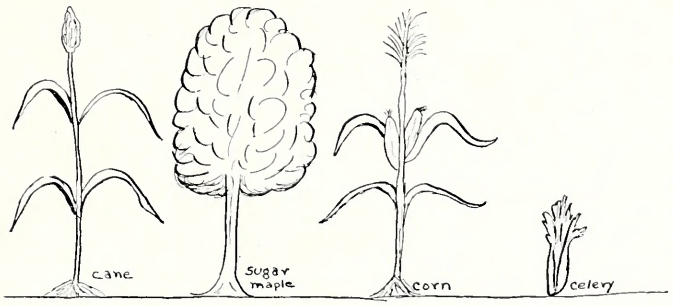
Wind scatters seeds



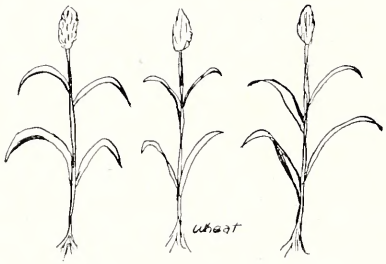
Every tree cut down should be replaced

We should grow foods in our garden each season



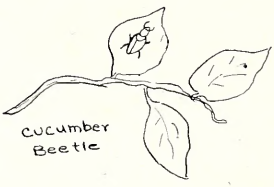


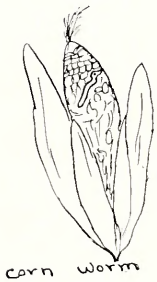
Some plants store food in their stems

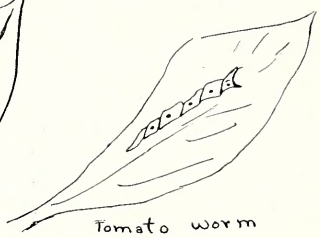


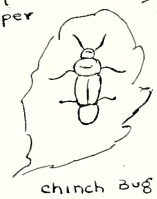
Some plants store food in the seed

Some animals eat leaves

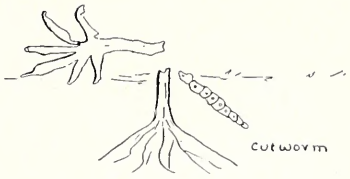






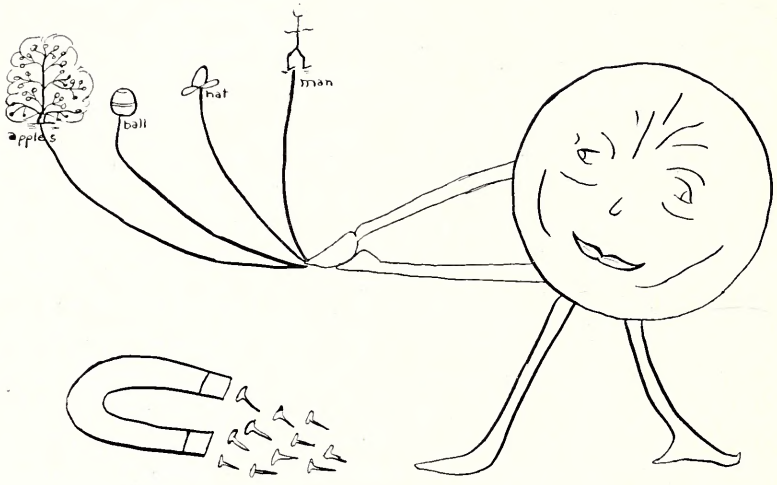


Some animals cut stems



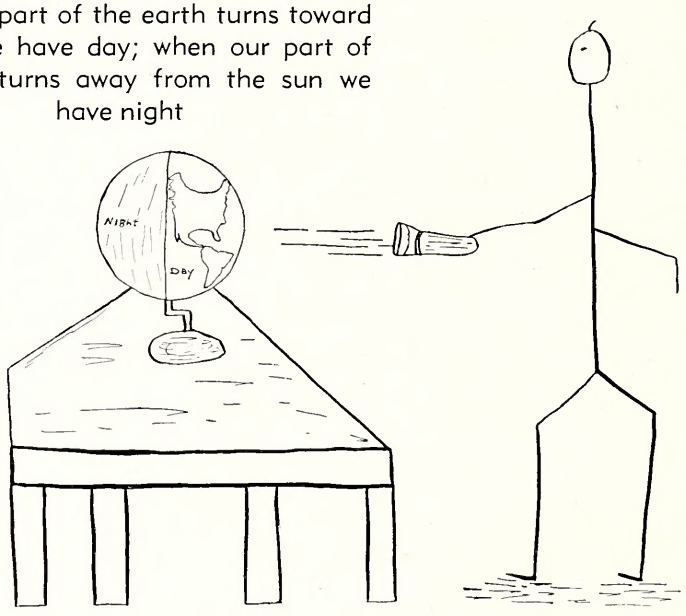
Some plants are not food and are poisonous

Rain washes our soil away

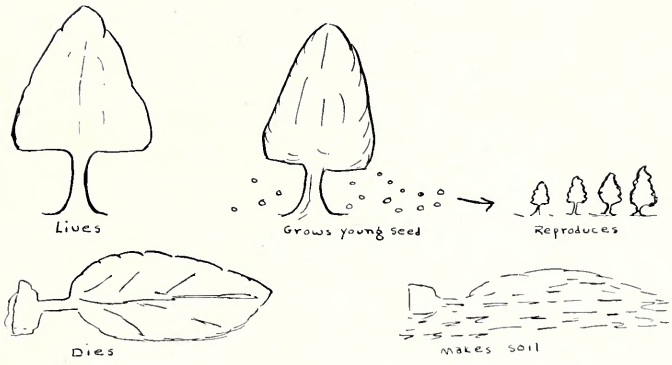


The earth pulls everything to it like a magnet

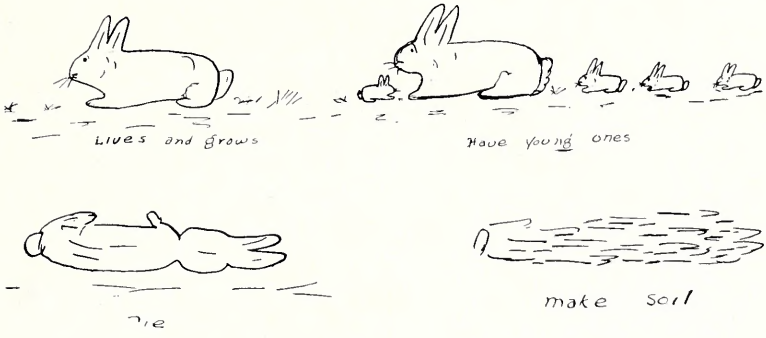
When our part of the earth turns toward the sun we have day; when our part of the earth turns away from the sun we have night



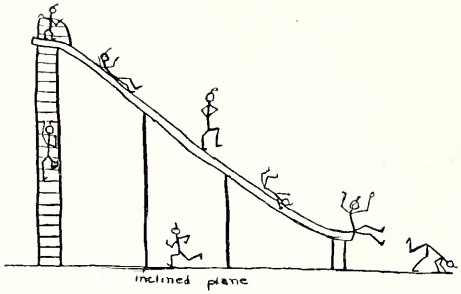
Many stars in the night sky are really suns

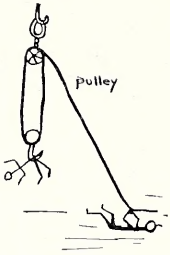


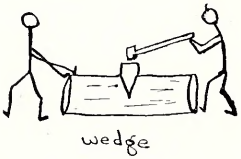
All plants live, have their young, die and make soil

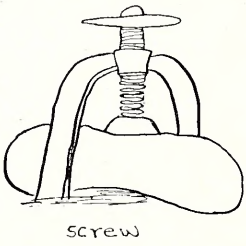


Animals live, grow, have young ones, die and make soil

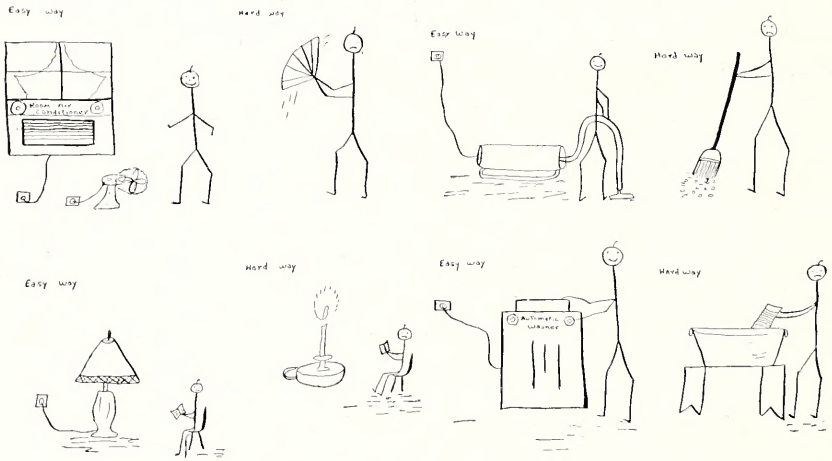




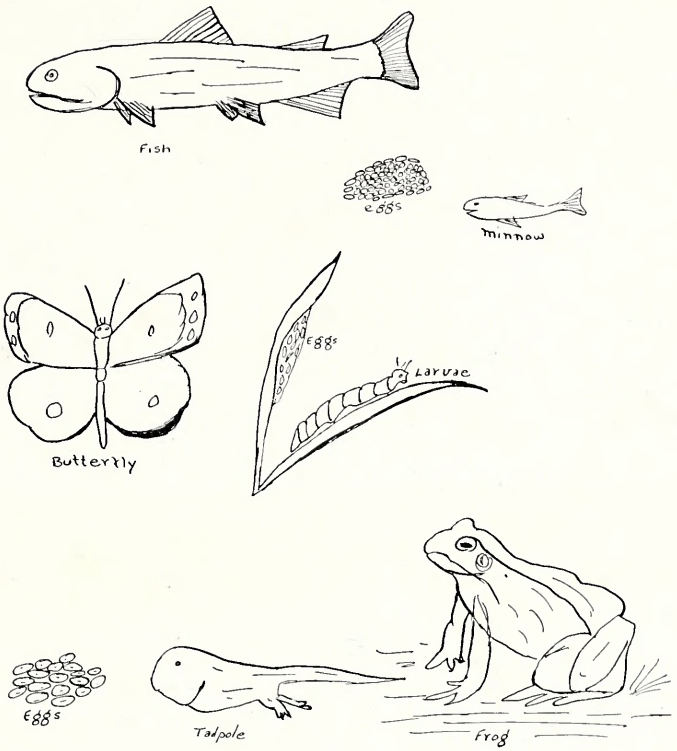




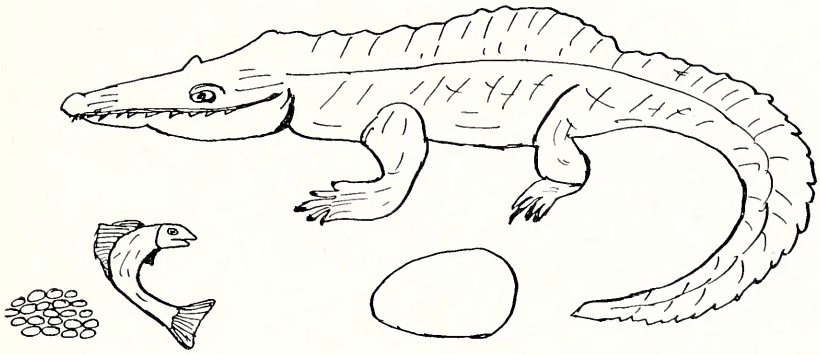
Simple machines make work and play easier



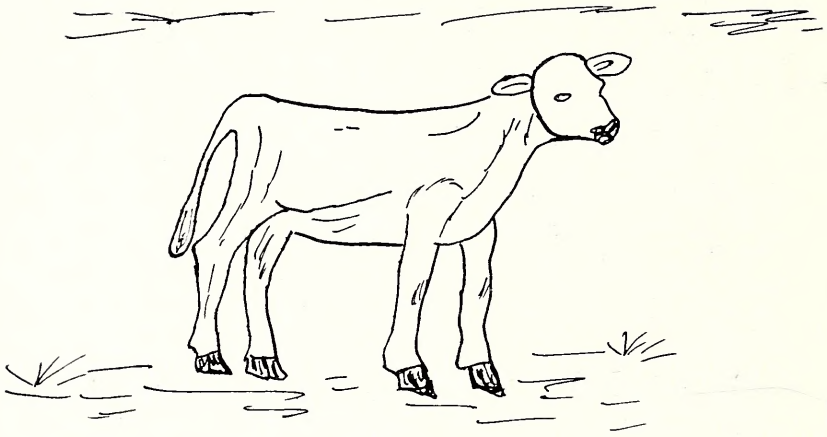
Electricity makes work easier



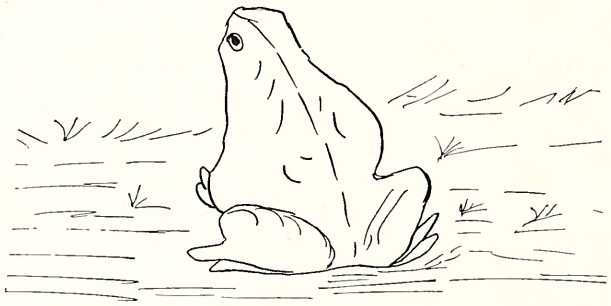
Some animals do not care for their young



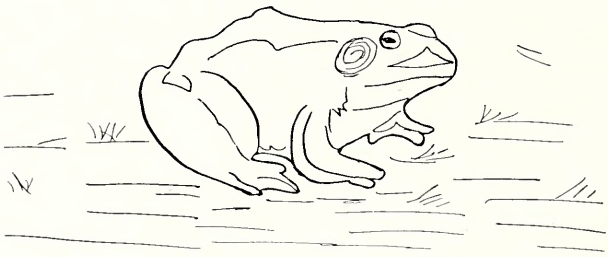
Some animals that have scales are hatched from eggs



Animals that have hair are born alive



Some animals breathe through their skin



Some animals that have skin are hatched from eggs

Actual homes for their school bird sanctuary

Single topics "give 'way" to groups as **common** animals in science study

APPRAISING THE CHILD'S GROWTH

We have expressed the belief that children may differ in their rate of growth. If our practices conform to that belief, we have to watch ourselves as adults, that we give each child time to grow in relation to those differences. Observable growth may be very slow and for that child, that is right. For another, growth may be very fast. But it is more desirable to see children who are consistently developing than to see high interests by "spurts"—whatever their speed of growth.

Growth in Science should indicate that the child is changing in his behavior to more scientific ways of thinking and doing. Knowledge of measurable facts is just one segment of his development.

> The evaluation of a child's growth should be in terms of more than facts.

Objective tests do not show some of the most valuable areas of development. The child's ability to use Science concepts in reasoning through problems which he meets in his everyday living is one area that tests do not reveal.

In appraising a child's growth, would we not expect to see evidences of the following:

1. An observable pleasure in searching for the "why."
2. A desire for accuracy.
3. A growing recognition of forms of change about him, as in the earth's crust.
4. A growing awareness of cause and effect relationships.
5. An apparent desire to search for cause and effect relationships.
6. A growing tendency to withhold personal judgments until all available materials pertinent to the subject have been considered.
7. The practice of applying the principles of Science which relate to better care of the human body.
8. Notable respect for the work of scientists and their contributions.
9. More power in interpreting the phenomena about him.
10. A desire for truth.

EVALUATING TEACHING PRACTICES

Appraising Instructional Practices

Good methods of evaluating call attention to teaching procedures which contribute to the objectives of elementary science.

The following checklist, prepared by two specialists in Elementary Science, is *not* intended to be a measure of "how good" a teacher is, but rather to encourage improvements based on the teacher's awareness of these points. It can be used by an individual, a school faculty, or by a county or city group as one of their aids in evaluating practices.

I. In my teaching is there opportunity or provision for children to:

	None	Some	Much
(a) Raise questions and problems of importance or interest to them?	____	____	____
(b) Study these questions and problems?	____	____	____
(c) Help plan "things to do" in studying science problems?	____	____	____
(d) State clearly the problems on which they are working?	____	____	____
(e) Make hypotheses to be tested?			
(f) Gather accurate data (information) in a variety of ways:			
Through reading on the subject?	____	____	____
Through taking field trips?	____	____	____
Through watching demonstrations?	____	____	____
Through doing experiments?	____	____	____
Through talking to resource persons?	____	____	____
(g) Analyze the data (information) to see how it relates to the problem?	____	____	____
(h) Think about the applications of their science learnings to everyday living?	____	____	____

(i) Think about science relationships and processes instead of merely naming things and learning isolated facts? ____ ____ ____

(j) Bring science materials of different kinds to school for observation and study? ____ ____ ____

(k) Engage in individual science interests? ____ ____ ____

II. In my teaching do I periodically and systematically check on the children's growth in:

	None	Some	Much
(a) Ability to locate and define problems right around them?	____	____	____
(b) Acquiring information on the problem being studied?	____	____	____
(c) Ability to observe more accurately?	____	____	____
(d) Ability to make reports on or record their observations?	____	____	____
(e) Ability to solve problems?	____	____	____
(f) Alibity to think critically?	____	____	____
(g) Ability to explain natural phenomena?	____	____	____
(h) Ability to distinguish between facts and fancies?	____	____	____
(i) Suspending judgement until evidence is collected?	____	____	____
(j) Being open-minded, or willing to change belief?	____	____	____
(k) Cooperating with others?	____	____	____
(l) Understanding the cause and effect relationships of events?	____	____	____
(m) Skill in using common scientific instruments (Thermometers, scales, rulers.)	____	____	____

Reference.

1. Blough and Blackwood. *Education Brief* No. 21, Feb. 1951, U. S. Office of Education, Washington 25, D. C.

IN-SERVICE WORKSHOPS

In-Service Workshops have proven their value in educational programs. An effective aspect of any workshop is that it provides for "learning by doing." The terms, co-operative planning, sharing, working together, and evaluating are lifted out of print and put into action in a live workshop situation.

The following three excerpts of what "went on" in Science Workshops show effective programs:

Example A. A CITY UNIT WORKSHOP

The teacher, principals and elementary supervisor of a city system did pre-planning and re-planned as they worked in this informal Science workshop in the session of 1952-53. Their point of view is inclusive in their selected workshop caption.

> "Where there is study, improvement and growth, in my profession, I want to be there."

Enriching science teaching "took on" new meaning within this group as they became:

—committee leaders.
—consultants (between groups).
—discussants on trends, purposes and materials.
—discussants of curriculum guides and manuals.
—demonstrators, at times.
—more objective about the child and his Science.
—planners on the most suitable time, place and hours for the meetings.

The five workshop sessions were relaxing from friendly exchanges of ideas and "interests" over a beginning sip of tea or coffee. After that, one hour or more of genuine work went on. Results? Not anything immediately startling. It was not planned that way. But results were there: In the classrooms, in the spirit of being a partner, in their beliefs.

Example B. A COUNTY UNIT WORKSHOP

All the seventh grade teachers in the county formed one workshop group and the eighth grade people another one. There was one large group of all first and second grade people. Each group

selected a chairman and steering committee, all with the same aim: To promote a more functional science program.

Although the programs were different from group to group, each workshop was planned so that as many teachers as possible made contributions.

Discussions and activities, with modifications to meet the needs of each group, were selected as follows:

1. *Materials for Science,* including an exhibit and discussion of texts, supplementary readers, library books, reference materials, pictures, and charts printed in the classrooms.
2. *Methods,* including discussions of books by Craig and Blough, demonstrations of techniques, and simple experiments.
3. *Equipment,* featuring an exhibit of simple, "home made" equipment and explanation of its use.
4. *Local Resources for Science,* centering around these questions.
   What in the county is worth studying? Where is it? How can a profitable visit or contact be made? What people can we use as resources?
5. *Audio-Visual Aids,* with emphasis on selection and use of film strips. Some films and film strips were previewed.

Example C. A SCHOOL FACULTY WORKSHOP

The principal and teachers felt that before they could lead children in science, it was well to discuss the problems in science instruction as they saw it. The principal of the school led the discussions. The outline, which will be their working basis for a year or more to come, came from their discussions:

A. First Concerns in Improving Elementary Science Instruction.
   The Child
   1. His interest in things of his environment and of his world.
   2. His interest and program in the early grades.
   3. His abilities vary.

B. Some obstacles that might stand in the way of better Elementary Science.
   1. The preparation of teachers (some feel unprepared).
   2. The use of time.
   3. Lack of use of materials and equipment.

C. Values of Elementary Science Should Develop.
   1. Critical and scientific thinking.
   2. Power to solve problems.

3. More desirable habits and attitudes.
4. A better citizen by aid in better health habits.
5. The means for more sound conclusions.

D. Methods and Procedures that Are of Conspicuous Value.
1. The use of a curriculum guide for continual development.
2. Use of pupils' ideas or hypotheses in problem solving.
3. Joint planning by teachers and pupils on their responsibilities.
4. Use of discussion procedures.
5. Use of pictures, exhibits, specimens, and discovery table.
6. Use of field trips, observation, experiments and community resources.
7. Correlation of science with other areas of work.

E. Securing leadership.
1. Selection of science committee.
2. Selection of secretary.
3. Making plans.

F. Selection of materials and equipment.
1. Survey.
   a. Things children can bring.
   b. Things found in school.
2. Ways of securing other needed materials and equipment.
   a. Course of study.
   b. Books.
   c. Audio-visual aids.
   d. Stock of supplies.

G. In-service training of teachers to:
1. Become acquainted with science books on the elementary level.
2. Become more aware of the needs and interests of children.
3. Recognize scientific attitudes and methods.
4. Try out demonstrations by the teachers.

H. Evaluation of the science program.
1. Have we realized our purposes?
2. Did our guiding principles aid us in developing the program?
3. Did the staff profit by this program?
4. Did the students profit by it?
5. What are some strengths and weaknesses of the science program?
6. How can we improve the science program in our school?

A SCIENCE LIBRARY FOR BOYS AND GIRLS

As boys and girls become interested in the various aspects of science, they demand more and more information on particular subjects. A library of science books and materials which supplement the facts in the textbook becomes a necessity. To aid teachers and the young people themselves, a list of books has been prepared with the titles grouped under the subject areas around which the course of study in science has been developed.

In preparing this limited list of books for a well-rounded science program, attention has been given to levels of reading ability as well as to subjects covered. For example, under the heading WEATHER, there is the delightful story of the seasons which came to *THE LITTLE HOUSE* and also the more mature interpretation of seasons in *EVERYBODY'S WEATHER.* The books are for the most part of middle grade reading level.

Some titles fit equally well under more than one subject, but have been listed only once. There are such excellent books of a general nature, however, that a GENERAL heading has also been used. Books listed under GENERAL include material on all of the large subject areas.

> Reading is an important tool to use in learning science.

All of the titles listed are included in the Library Book Catalogue prepared by the State School Library Adviser and may be purchased from the Division of Textbooks, State Board of Education. In addition, the Library Book Catalogue includes many more equally good books with science content. New books are added to the catalogue each year. Reliable book selection aids for elementary schools list many others. Familiarity with the names of outstanding writers for boys and girls in the field of science also helps in the selection of additional materials. Among the better known writers are Meyer, Schneider, Bronson, Blough, Zim, Selsam, and Fenton.

> Reliable lists should be used in the selection of science books for the library.

Books in the science library must be interesting, accurate, up-to-date, and attractively and appropriately illustrated. But the books will not fully serve their purpose, unless the boys and girls know how to use them effectively. Care must be taken to see that pupils know how to use an index and a table of contents, how to read charts and diagrams, how to read factual material for accuracy even at the expense of speed, how to study and interpret pictures, how to follow directions accurately in experimentation, and how to search out additional material on a topic which needs expansion. Skill in locating, interpreting, and using library materials is of especial importance to the science scholar.

As boys and girls become more and more aware of the world about them, they will seek additional information. This list of books is designed as the first step in meeting this growing need.

> Skill in using books for information is necessary in scientific research.

ANIMALS

Bronson, Wilfred S. *The Wonder World of Ants.* Harcourt, 1937. $2.00 (4-6)

Colby, Carroll. *Who Went There?* Aladdin, 1953. $1.00 (4-6)

Earle, Olive L. *Robins in the Garden.* Morrow, 1953. $2.00 (1-4)

Fenton, C. L. *Wild Folk In the Woods.* John Day, 1952. $2.50 (4-6)

Friskey, Margaret. *Johnny and the Monarch.* Childrens Press. 1946. $2.00 (1-2)

Green, Ivah. *Animals Under Your Feet.* Grosset, 1953. $2.75 (3-8)

Hoke, John. *First Book of Snakes.* Watts, 1952. $1.75 (3-5)

Huntington, Harriet E. *Let's Go To the Seashore.* Doubleday, 1941. $2.50 (2-5)

Kieran, John. *Introduction to Birds.* Garden City, 1950. $2.50 (5-9)

Martin, Dahris. *Little Lamb.* Harper, 1938. $1.75 (1-2)

Tibbets, Albert R. *The First Book of Bees.* Watts, 1952. $1.75 (5-8)

Zim, Herbert S. *Alligators and Crocodiles.* Morrow, 1952. $2.00 (4-7)

Zim, Herbert S. *What's Inside of Animals?* Morrow, 1953. $1.75 (3-8)

PLANTS

Cormack, Maribelle. *First Book of Trees.* Watts, 1951. $1.75 (3-7)

Gould, Dorothea. *Very First Garden.* Oxford, 1943. $0.50 (3-5)
Webber, Irma E. *Bits That Grow Big.* Scott, Wm. R., 1949. $2.00 (2-4)
Webber, Irma E. *Up Above and Down Below.* Scott, Wm. R., 1943. $1.25 (2-4)
Zim, Herbert S. *What's Inside of Plants?* Morrow, 1952. $1.75 (3-8)

WEATHER

Burton, Virginia Lee. *The Little House.* Houghton, 1942. $2.50 (1-4)
Flack, Marjorie. *Restless Robin.* Houghton, 1937. $2.50 (1-4)
Gaer, Joseph. *Everybody's Weather.* Lippincott, 1944. $2.50 (5-8)
Gall, Alice. *Winter Flight.* Oxford, 1949. $2.50 (4-5)
Hylander, Clarence J. *Out of Doors in Autumn.* Macmillan, 1942. $2.25 (5-9)
Schneider, Herman. *Folow the Sun.* Doubleday, 1952. $2.75 (1-3)
Schneider, Herman. *Everyday Weather and How It Works.* McGraw-Hill, 1951. $2.75 (5-8)
Zim, Herbert S. *Lightning and Thunder.* Morrow, 1952. $2.00 (4-8)
Zolotow, Charlotte. *The Storm Book.* Harper, 1952. $2.00 (2-3)

MAGNETS

Yates, Raymond F. *Boy's Book of Magnetism.* Harper, 1941. $2.50 (5-8)

ELECTRICITY, ENERGY, POWER, CHARGE, FORCE

Bechdolt, John E. *Going Up.* Abingdon-Cokesburg, 1948. $2.00 (4-8)
Britton, Katherine. *What Makes It Tick?* Houghton, 1943. $3.00 (5-8)
Elting, Mary. *Machines at Work.* Doubleday, 1953. $1.50 (5-8)
Gail, Otto W. *Romping Through Physics.* Knopf, 1934. $2.50 5-8)
Huey, Edward G. *What Makes the Wheels Go Round.* Harcourt, 1940. $2.50 (5-8)
Lewellen, John B. *You and Atomic Energy.* Childrens Press, 1949. $1.50 (5-8)
Meyer, Jerome S. *Picture Book of Radio and Television.* Lothrop, 1951. $2.00 (5-8)
Peet, Creighton. *How Things Work.* Holt, 1941. $2.50 (4-7)
Schneider, Herman. *Everyday Machines and How They Work.* McGraw-Hill, 1950. $2.50 (5-8)
Zaffo, George L. *Big Book of Real Trucks.* Grosset, 1950. $1.75 (2-5)
Zim, Herbert S. *What's Inside of Engines?* Morrow, 1953. $1.75 (3-8)

HOMES

Adelson, Leone. *All Ready For Winter.* McKay, 1952. $2.00 (1-2)
Colby, Carroll. *Who Lives There?* Aladdin, 1953. $1.00 (4-6)
Earle, Olive L. *Birds and Their Nests.* Morrow, 1952. $2.00 (6-8)
Gustavson, Harry. *Up Goes the House.* Oxford, 1947. $1.25 (1-2)
Mason, George F. *Animal Homes.* Morrow, 1947. $2.00 (5-8)
Sprinkle, Rebecca K. *A House for Leander.* Abingdon-Cokesbury, 1953. $1.50 (3-4)

THE UNIVERSE-THE EARTH

Dakin, Wilson S. *Great Rivers of the World.* Macmillan, 1925. $2.00 (5-7)
Elms, Francis R. *Mountains of the World.* Whitman, 1941. $2.00 (4-6)
Fenton, Carroll L. *Land We Live On.* Doubleday, 1944, $2.50 (5-8)
Galt, Thomas F. *Volcano.* Scribner, 1946. $2.50 (4-6)
Meyer, Jerome S. *Picture Book of the Earth.* Lothrop, 1949. $2.00 (5-8)
Reed, William M. *Earth For Sam.* Harcourt, 1930. $3.75 (5-8)
White, Anne Terry. *Prehistoric America.* Random House, 1951. $1.50 (5-8)

THE UNIVERSE-BEYOND THE EARTH

Brindze, Ruth. *The Story of Our Calendar.* Vanguard, 1949. $2.50 (4-8)
Dunham, Miriam. *What's In the Sky.* Oxford, 1941. $1.50 (4-8)
Meyer, Jerome S. *Picture Book of Astronomy.* Lothrop, 1945. $2.00 (3-5)
Rey, H. A. *Stars.* Houghton, 1952. $4.00 (6-8)
Washburne, Carlton. *Story of Earth and Sky.* Appleton, 1935. $1.88 (6-8)

AIR AND WATER

Bendick, Jeanne. *The First Book of Space Travel.* Watts, 1953. $1.75 (4-8)
Brindze, Ruth. *Gulf Stream.* Vanguard, 1945. $2.50 (4-6)
Coy, Harold. *The Real Book About Rivers.* Doubleday, 1953. $1.25 (5-8)
Lewellen, John. *Birds and Planes: How They Fly.* Crowell, 1953. $2.00 (6-9)
Norling, Jo and Ernest. *The First Book of Water.* Watts, 1952. $1.75 (4-6)
Webber, Irma E. *Travelers All.* Scott, Wm. R., 1944. $1.25 (2-4)

ROCKS, MINERALS AND SOILS

Cormack, Maribelle. *First Book of Stones.* Watts, 1950. $1.50 (4-6)

Fenton, Carroll L. *Riches From the Earth.* John Day, 1953. $2.75 (5-8)

Fenton, Carroll L. *Rocks and Their Stories.* Doubleday, 1951. $2.50 (7-9)

CONSERVATION

Gilbert, Helen E. *Mr. Plum and the Little Green Tree.* Abingdon-Cokesbury, 1946. $2.00 (1-3)

Graham, Edward and Van Dersal, William. *Wildlife for America.* Oxford, 1949. $2.50 (6-9)

Lathrop, Dorothy. *Let Them Live.* Macmillan, 1951. $2.00 (4-7)

Reed, W. Maxwell. *America's Treasure.* Harcourt, 1939. $3.50 (5-9)

Shippen, Katherine. *The Great Heritage.* Viking, 1947. $3.50 (7-8)

Wall, Gertrude W. *Gifts From the Forest.* Scribner, 1952. $2.50 (5-8)

SOUND

Baer, Marian E. *Sound: An Experiment Book.* Holiday, 1952. $2.50 (5-8)

Holton, Gerald James. *Story of Sound.* Harcourt, 1948. $2.00 (5-9)

Leeming, Joseph. *The Real Book About Easy Music-Making.* Garden City, 1952. $1.25 (5-8)

MacGregor, Ellen. *Tommy and the Telephone.* Whitman, 1947. $1.50 (1-2)

LIQUIDS, GAS AND SOLIDS

Meyer, Jerome S. *Picture Book of Chemistry.* Lothrop, 1950. $2.00 (5-8)

MOLECULES, ELEMENTS AND COMPOUNDS

Lewellen, John. *You and Atomic Energy and Its Wonderful Uses.* Childrens Press, 1949. $1.50 (6-9)

Meyer, Jerome, *Picture Book of Molecules and Atoms.* Lothrop, 1948. $2.00 (5-9)

Schneider, Herman. *How Big Is Big?* Scott, Wm. R., 1950. $1.75 (2-4)

LIGHT

Lacey, Ida Belle. *Light Then and Now.* Macmillan, 1930. $1.50 (3-5)

Menzel, Donald Howard. *Our Sun.* Blakiston, 1949. $4.50 (7-8)

Zim, Herbert S. *The Sun.* Morrow, 1953. $2.00 (3-8)

HEALTH AND SAFETY

Eberle, Irmengarde. *Basketful: The Story of Our Foods,* Crowell, 1946. $2.50 (6-8)

Leaf, Munro. *Health Can Be Fun.* Lippincott, 1943. $1.75 (2-4)

Leaf, Munro. *Safety Can Be Fun.* Lippincott, 1938. $1.75 (2-4)
Schneider, Herman. *How Your Body Works.* Scott, Wm. R., 1949. $2.75 (4-7)
Stack, H. J. *Safety In the World Today.* Beckley-Cardy, 1948. $1.75 (6-9)
Tharpe, R. W. *Your Teeth—Their Importance and Care.* Laidlaw, 1950. $1.80 (5-9)
Zim, Herbert S. *What's Inside of Me?* Morrow, 1952. $1.75 (4-8)

BOOKS FOR IDENTIFICATION

Aldrich, D. E. and Snyder, Ethel. *Florida Sea Shells.* Houghton, 1936. $2.00
Collingwood, George H. *Knowing Your Trees.* American Forestry Association, 1947. $5.00
Hogner, Dorothy. *Animal Book.* Oxford, 1942. $4.00
Loomis, Frederic B. *Field Book of Common Rocks and Minerals.* Putnam, 1923. $3.95
North Carolina State Museum. *Reptiles of North Carolina.* State Museum, Raleigh. Free.
Zim, Herbert S. *Birds.* Simon and Schuster, 1949. $1.50
Zim, Herbert S. *Flowers.* Simon and Schuster, 1950. $1.50
Zim, Herbert S. *Insects.* Simon and Schuster, 1951. $1.50
Zim, Herbert S. *Stars.* Simon and Schuster, 1951. $1.50
Zim, Herbert S. *Trees.* Simon and Schuster, 1951. $1.50
Matschat, Cecile. *American Butterflies and Moths.* Random House, 1942. $1.00

SCIENCE EXPERIMENT BOOKS

Baer, Marian E. *Experiments Without Fire.* Rinehart, 1947. (o. p. 1951) (1-5)
Beeler, Nelson F. and Branley, Franklin M. *More Experiments In Science.* Crowell, 1950. $2.50 (5-7)
Beeler, Nelson F. and Branley, Franklin M. *Experiments With Electricity.* Crowell, 1949. $2.50 (5-8)
Freeman, Ira M. *Invitation to Experiment.* Dutton, 1940. $2.75 (7-9)
Freeman, Mae and Freeman, Ira M. *Fun With Chemistry.* Random House, 1944. $1.50 (3-9)
Freeman, Mae and Freeman, Ira M. *Fun With Science.* Random House, 1943. $1.50 (3-9)
Keeler, Katherine L. *Working With Electricity.* Macmillan, 1938. $2.00 (3-8)
Morgan, Alfred P. *An Aquarium Book for Boys and Girls.* Scribner, 1936. $2.50 (5-8)
Morgan, Alfred P. *The Boy Electrician.* Lothrop, 1948. $3.00 (7-12)
Morgan, Alfred P. *Boy's Book of Science and Construction.* Lothrop, 1948. $3.00 (7-12)
Morgan, Alfred P. *A First Electrical Book for Boys.* Scribner, 1951. $3.00 (5-9)

Morgan, Alfred P. *Simple Chemical Experiments.* Appleton-Century, 1941. $3.00 (5-12)
Morgan, Alfred P. *Things A Boy Can Do With Chemistry.* Appleton-Century, 1940. $2.50 (7-12)
Morgan, Alfred P. *Things A Boy Can Do With Electricity.* Scribner, 1938. $2.50 (7-12)
Schneider, Herman and Schneider, Nina. *Let's Find Out.* Scott, Wm. R., 1946. $2.25 (1-4)
Schneider, Herman and Nina. *Science Fun With Milk Cartons.* McGraw-Hill, 1953 $2.50 (4-8)
Selsam, Millicent. *Play With Leaves and Flowers.* Morrow, 1952. $2.00 (3-8)
Yates, Raymond F. *A Boy and A Battery.* Harper, 1942. $2.00 (5-8)
Wyler, Rose. *The First Book of Science Experiments.* Watts, 1952. $1.75 (5-8)

GENERAL

Buck, Margaret W. *In Woods and Fields.* Abingdon-Cokesbury, 1950. $3.00 (3-6)
Comstock, Anna. *Handbook of Nature-Study.* Comstock Publishing Company, 1939. $6.00 (1-8)
Freeman, Mae and Ira. *Fun With Science.* Random House, 1943. $1.50 (5-8)
Huntington, Harriet E. *Let's Go Outdoors.* Doubleday, 1939. $2.50 (1-4)
Morgan, Alfred Powell. *Boys' Book of Science and Construction.* Lothrop, 1948 $3.00 (6-9)
Parker, Blough and Others. *Basic Science Education Series.* Row, Peterson and Company. (1-8)
Individual titles are listed in the North Carolina Supplementary Reader Catalogue.
Verrill, Alpheus. *Young Collector's Handbook.* MacBride, 1948. $2.75 (5-8)

SOME SUGGESTED AUDIO-VISUAL MATERIALS

Films and Filmstrips

Out of the abundance of films and filmstrips this list is suggested with the idea of help to you. No *attempt has been made to make an exhaustive list.* Too, film producers are constantly in the process of making new and additional material available. It would be impossible to list all producers in a suggested list. Grade levels are only suggested. They are made to relate to the elementary science program. Many of the films and filmstrips listed may be used at higher levels.

Any good film or filmstrip with enough pre-planning can be helpful, when it fits into the subject and program.

Use of Slides

Slides, particularly colored ones, help to vitalize subjects of the curriculum. Since there are so many available, the teaching aspect should be kept in mind.

In the sources suggested are the catalogs of the various film companies; the "Educational Film Guide" and "Filmstrip Guide," H. W. Wilson Company, 950 University Avenue, New York 52, N. Y. There are also some excellent commercial films and filmstrips. There are also some films and filmstrips produced by textbook publishers.

> Previewing many of one subject and selecting the best is important.

ABBREVIATIONS

Suggested Grade Levels
P—primary
I—intermediate
U—upper elementary
C W—Churchill-Wexler
Coronet—Coronet Instructional Films
EBF—Encyclopedia Britannica Films, Inc.
Intfilm-Bur—International Film Bureau
Ott—John Ott Productions
Johnson-Hunt—Johnson Hunt Productions
McGraw-Hill—McGraw-Hill Book Company
UWF—United World Films, Inc.
YAF—Young America Films, Inc.

35mm FILMSTRIPS

Some suggested series of filmstrips are listed. *Individual filmstrips may be purchased from any series.* There are numerous filmstrips in the area of elementary science that are not a part of a series. Space does not permit individual listing here. It is very necessary to preview and purchase *only* the ones of a series that fit the content best.

SOIL CONSERVATION	EBF	I - U
ANIMAL FRIEND SERIES	EBF	P - I
ELEMENTARY SCIENCE SERIES	EBF	U
SAFETY STORIES SERIES	EBF	P
THE SKY SERIES	Jam Handy	I - U
OUR EARTH SERIES	Jam Handy	I - U
WATER LIFE SERIES	Jam Handy	I - U
HEALTH ADVENTURE SERIES	Jam Handy	U
AMERICAN BIRDS GUIDE	YAF	I - U
AMERICAN WILDFLOWER GUIDE	YAF	I - U
AMERICAN INSECT GUIDE	YAF	I - U
BASIC BIRD SERIES	Jam Handy	I - U
ELEMENTARY SCIENCE SERIES Set No. 1, 2, and 3.	YAF	P - I - U
PRIMARY HEALTH SERIES	YAF	P
GOOD HEALTH SERIES	YAF	I - U
MATTER—ENERGY	Pop Science	I - U
PHYSICAL AND CHEMICAL CHANGES IN EVERDAY LIVING	Pop Science	I - U
WEATHER	Pop Science	I - U
HEALTH AND SAFETY	Eyegate	P - I - U
PRIMARY HEALTH SERIES	SVE	P - I
SCIENCE I (Intermediate Series)	Curriculum	I
BASIC SCIENCE SERIES	SVE or Row, Peterson	I - U
ELEMENTARY NATURE STUDY SERIES	SVE	P - I
ELEMENTARY SCIENCE SERIES	VIS	U
WHY SERIES	SVE	P - I
ELEMENTARY METEOROLOGY SERIES	SVE	U

Reference Filmstrip Sources.

Curriculum—Curriculum Films, Inc., 10 E. 40th Street, New York 16, N. Y.

EBF—Encyclopedia Britannica Films, Inc., 1150 Wilmette Avenue, Wilmette, Illinois.

Eye Gate—Eye Gate House, Inc., 2716 41st Avenue, Long Island City, New York.

Jam Handy—Jam Handy Organization, 2821 E. Grand Boulevard, Detroit 11, Michigan.

Popscience, "Teach-O-Filmstrips"—Popular Science Publishing Company, A-V Department, 353 Fourth Avenue, New York 10, N. Y.

SVE—Society for Visiual Education, Inc., 1345 West Diversey Parkway, Chicago, Illinois.

YAF—Young America Films, Inc., 18 East 41st Street, New York 17, New York.

VIS SCIENCES—Visual Science, Suffern, N. Y. Box 599.

16mm FILMS BY SUBJECTS

Animals

FARM ANIMALS	EBF	P - I
THE FROG	EBF	I - U
HONEY BEE	EBF	I - U
GRAY SQUIRREL	EBF	P
CARE OF PETS	EBF	P - I
HOW ANIMALS DEFEND THEMSELVES	YAF	P - I - U
HOW ANIMALS MOVE	YAF	P - I - U
MONARCH BUTTERFLY STORY	EBF	I - U
ATTRACTING BIRDS IN WINTER	Int-Film Bur	P - I - U
BUILDING BIRD HOUSES	Int-Film Bur	P - I - U
CULTIVATE YOUR GARDEN	Int-Film Bur	P - I - U
BIRDS	Int-Film Bur	P - I - U
LIFE IN A DROP OF WATER	CORONET	U
SUNFISH	EBF	I - U
ZOO	EBF	P - I
ANTS	EBF	I - U
CAMOUFLAGE IN NATURE THRU PATTERN MATCHING	CORONET	I - U
HOW ANIMALS EAT	YAF	P - I - U
INSECT ZOO	EBF	P - I - U
LIFE ALONG THE WATERWAYS	EBF	I - U
LIFE IN AN AQUARIUM	YAF	I - U
WONDERS IN A COUNTRY STREAM	C - W	P - I
WONDERS IN YOUR OWN BACKYARD	C - W	P - I

SEASHORE LIFE	EBF	I - U
LIFE CYCLE OF THE MOSQUITO, THE	YAF	I - U
MOTHS	EBF	I - U
SNAPPING TURTLE	EBF	I - U
HOUSE FLY	EBF	U
BABY ANIMALS	YAF	P - I

Plants and Animals

AUTUMN ON THE FARM	EBF	P - I
WINTER ON THE FARM	EBF	P - I
SPRING ON THE FARM	EBF	P - I
SUMMER ON THE FARM	EBF	P - I
POND LIFE	EBF	P - I
LIFE IN AN AQUARIUM	YAF	P - I

Plants

THE GROWTH OF FLOWERS	CORONET	U
SEASONAL CHANGES IN TREES	CORONET	I - U
LIFE OF A PLANT	EBF	I - U
SEED DISPERSAL	UWF	U
ROOTS	UWF	U
PHOTOSYNTHESIS, BY	UWF	U
SELF-DEFENSE PLANTS	UWF	U
LEAVES	EBF	U
CLIMBING PLANTS	UWF	U

Weather

WEATHER	EBF	U
WHAT MAKES RAIN	YAF	P - I - U
WHAT MAKES A DESERT	YAF	I - U
WINDS AND THEIR CAUSES	CORONET	I - U
CLOUDS ABOVE	JOHNSON HUNT	I - U
STORY OF A STORM, A	CORONET	I - U
ONE RAINY DAY	CORONET	P
WHAT THE FROST DOES	CORONET	P
WHAT CAUSES THE SEASONS	YAF	I - U
THUNDER AND LIGHTNING	YAF	I - U
PLAY IN THE SNOW		

Magnets

MAGNETS	YAF	I - U

EL. - ENERGY - POWER - CHANGE

THE FLOW OF ELECTRICITY	YAF	I - U
PRINCIPLES OF THE GENERATOR, THE	YAF	I - U
THE STEAM ENGINE	YAF	I - U
THINGS EXPAND WHEN HEATED	YAF	I - U

WATER WORKS FOR US	YAF	I - U
MATTER AND ENERGY	CORONET	I - U
OUR COMMON FUELS	CORONET	I - U
ATOMIC ENERGY	EBF	U
THE FORCE OF GRAVITY	YAF	I - U
MACHINES DO WORK	YAF	I - U
ELECTROMAGNETS	YAF	I - U
FRICTION	YAF	I - U

Homes

(Animal homes shown in animal pictures)

THE UNIVERSE

A. The Earth

UNDERSTANDING OUR EARTH: GLACIERS	CORONET	I - U
UNDERSTANDING OUR EARTH: SOIL	CORONET	I - U
VOLCANOES IN ACTION	EBF	U
WEARING AWAY OF THE LAND	EBF	U
OUR EARTH	EBF	U
LATITUDE & LONGITUDE		
OUR CHANGING WORLD	OH	I - U

B. Beyond The Earth

WHAT MAKES DAY AND NIGHT	YAF	I - U
THIS IS THE MOON	YAF	I - U
THE SOLAR SYSTEM	CORONET	I - U
EXPLORING THE UNIVERSE	EBF	U
THE SOLAR SYSTEM	EBF	U

Air and Water

AIR ALL AROUND US	YAF	I - U
AIRPLANES AND HOW THEY FLY	YAF	I - U
WHAT MAKES THINGS FLOAT	YAF	I - U
AIR IN ACTION	CORONET	I - U
ATMOSPHERE AND ITS CIRCULATION	EBF	I - U
WORK OF RUNNING WATER	EFB	U
WATER POWER	EBF	I - U
PROPERTIES OF WATER	CORONET	I - U
WATER WORKS FOR US	YAF	I - U

Rocks, Minerals and Soils

BIRTH OF THE SOIL	EBF	I - U
OUR SOIL RESOURCES	EBF	I - U
UNDERSTANDING OUR EARTH: SOIL	CORONET	I - U

Conservation

THE STRAND GROWS	EBF	I - U
A STRAND BREAKS	EBF	I - U
EVERYMAN'S EMPIRE	UWF (U. S. Govt.)	P - I - U
TIMBER AND TOTEM POLES	UWF (U. S. Govt.)	I - U

Sound

SOUND WAVES AND THEIR SOURCES	EBF	U
WHAT IS SOUND	YAF	I - U
SCIENCE IN THE ORCHESTRA (Part I)	McGraw-Hill	I - U
SCIENCE IN THE ORCHESTRA (Part II)	McGraw-Hill	I - U

Liquids, Gas, Solids

SOLIDS, LIQUIDS, GASES	YAF	I - U

Molecules, Elements and Compounds

THE WONDER OF CHEMISTRY	YAF	I - U
SIMPLE CHANGE IN MATTER	CORONET	I - U

Light

THE NATURE OF LIGHT	CORONET	U
LIGHT AND SHADOW	YAF	I - U
TELEVISION: AND HOW IT WORKS	CORONET	U
HOW MAN MADE DAY	CORONET	I - U

Health and Safety

SAFETY ON THE SCHOOL BUS	YAF	P - I - U
SAFETY TO AND FROM SCHOOL	YAF	P - I - U
SAFETY BEGINS AT HOME	YAF	I - U
STREET SAFETY IS YOUR PROBLEM	YAF	P - I - U
BICYCLE SAFETY	YAF	P - I - U
PLAYGROUND SAFETY	CORONET	I - U
YOUR EARS	YAF	I - U
YOUR EYES	YAF	I - U
TEETH ARE TO KEEP	EBF	P - I - U
SLEEP FOR HEALTH	EBF	I - U
CARE OF THE SKIN	EBF	I - U
CARE OF THE HAIR AND NAILS	EBF	I - U
KITTY CLEANS UP	YAF	P
GROWING GIRLS	EBF	U
HOW TO BE WELL GROOMED	CORONET	U

SAFE USE OF TOOLS	CORONET	P - I - U
TOMMY'S DAY	YAF	P
WAYS TO GOOD HABITS	CORONET	I - U

(Refer to State *Health Education* bulletin, 1953, for other titles on Health)

Reference Film Sources.

Churchill-Wexler, 801 N. Seward Street, Los Angeles, California
Coronet Films, Inc. Coronet Building, Chicago 1, Illinois.
Encyclopedia Britannica Films, 1150 Wilmette Avenue, Wilmette, Illinois.
International Film Bureau, Inc. 57 East Jackson B'lc'd., Chicago 4, Illinois.
John Ott Pictures, Inc. 85 Hibbard Road, Winnentka, Illinois.
Johnson Hunt Productions, 1133 N. Highland Avenue, Hollywood 38, California.
McGraw-Hill Book Company, Textfilm Department, 330 W. 42nd Street, New York 18, N. Y.
United World Films, Inc., 1445 Park Avenue, New York 29, New York.
Young America Films, Inc., 18 East 41st Street, New York 17, New York.

Recording

Children like to listen as well as to see. Science recordings should be selected carefully so that their "listening" will benefit them. A balanced library of audio-visual materials should contain some recordings.

Albums:

Voices Of The Night	Comstock Publishing Co., Inc. Ithaca, New York
American Bird Songs	Comstock Publishing Co., Inc. Ithaca, New York

Single Records:

By Rocket To The Moon	Young People's Records, Inc.
What Makes Rain?	Decca. American. N. Y.
What Are Stars?	Decca. American. N. Y.
Songs Of Safety	Decca. American. N. Y.
Why Do I Have To Go To Sleep?	Decca. American. N. Y.

Some Sources For 2" x 2" Slides.

Carolina Biological Supply Co. Elon College, North Carolina. (a large and varied collection)
General Biological Supply House 761 East 69th Place, Chicago.
Society for Visual Education, Inc. 100 East Ohio St., Chicago.

MATERIALS AND APPARATUS AND SOURCES

Labeling and Placing

Purchasing and collecting materials is not more important than labeling and making them accessible. An attempt to keep all of the needed items in the classroom tends to make the room "junky" with Science materials. Too, the materials need to be shared with other teachers.

> The collecting, labeling and placing of basic supplies for accessible use should be a joint school enterprise.

There should be a Science cabinet for the school or for selected grades, with the materials there ready for use. Each school should have its own system for using them.

Naturally, the teacher and children will assemble the materials they need for a special study and then return them to their central place or source.

Education Briefs #1 on *Science Materials and Apparatus* says: "It is not necessary to spend a large amount of money for expensive apparatus. Most science experiments in the grade school are simple and rightly so. The materials, too, should be kept simple. *Home-made equipment often serves.* . . . .

The list of materials is considered to be about the minimum items necessary to teach usual grade-school science. How much of each item will depend upon the number of teachers in the school. This list is for the use of teachers in assembling some essential equipment for a central supply in a school. Units can be taught without having at hand every item in the list; you may have others:

I. Electricity and Magnetism.

Piece of lodestone
Pair of bar magnets
Large horseshoe magnet
U-magnet
Knitting needles
Iron filings
Magnetic needle
Magnetic compass
Fur for rubbing friction rods
Colored pith balls for static electricity
Demonstration electric motor
Telephone receiver
Telephone transmitter
Dry cells
Insulated copper wire
Electric push buttons

Glass friction rod
Hard rubber friction rod
Electric bell
Electric lamps and sockets (miniature)

II. Air and Weather.

Glass barometer tube with well
Medicine dropper for filling with mercury
Mercury (3 lbs. needed)
Tin cup

III. Sound and Light.

Tuning fork
Concave and convex mirror
Prism
Reading glass, 4-inch diameter
Color rotator to show the results of mixing colors

IV. Fire and Heat.

Boy Scout fire drill set
Ball and ring apparatus to show that metals expand when heated
Compound bar to show that some metals expand more than others when heated
Apparatus to show that heat travels faster in some metals than others
Apparatus to show that some substances conduct heat better than others

V. Living Things.

An aquarium (stocked with fish, snails, water plants) (not for each room)
A terrarium (stocked with growing plants, a suitable place to keep a small turtle, a frog, or salamander.) (not for each room)
Larvae of different kinds
Cocoons and chrysalides
Seeds (collectable)
Growing plants (geranium, ivy, begonia, cactus) (small)
An ant observation house

VI. Glassware.

Fruit jars
Milk bottles
Glass tumblers
Lamp chimneys
Cups and saucers
Window glass cut in small-sized pieces (smooth edge)
Glass graduate, 100 cc. capacity
Pyrex beakers (nest)
Pyrex flask—1 pt. size

Battery jar—small
Battery jar—large
Glass funnel, 100 mm. top diameter
Thermometer, double scale C and F
Glass tubing—6 mm, outside diameter
Test tubes 6″ x ¾″.

VII. Chemicals.

Soda
Starch
Sugar
Marble chips
Lime for limewater
Red ink
Vinegar
Table salt
Paraffin
Ammonia
Iodine
Dyes
Powdered sulphur
Powdered iron
Dilute hydrochloric acid

VIII. Miscellaneous.

Hot plate
Tongs for lifting hot objects
Iron spoon for heat and chemical work
Alcohol burner or Bunsen burner (Latter usable with gas)
Rubber tubing for Bunsen burner, ¼ inch inside diameter (only needed if you have gas), 4 feet
Rubber stoppers, solid, 1- and 2-hole, assorted sizes, 2-6
Corks, bag of assorted sizes, 12-26
Corks, bag of assorted sizes, 0-11
Test-tube brush
Test-tube holder
Rubber tubing, 3/16 inch inside diameter
Iron ring stand, large size
Clamp for ring stand
Iron ring with clamp for fastening on ring stand
Wire gauze with asbestos center for placing over rings or tripod
Iron tripod
Forceps for handling heated objects and chemicals
Safety matches
Scissors
Teaspoons and tablespoons
Tin cups
Scraps of different kinds of metal (as zinc, aluminum, copper)
Flower pots (small) for seeds
Petri dishes (for growth of bacteria)
Paring knife and table knife
Balls
Wire steel and copper
Flashlight

Scraps of different kinds of cloth (as silk, wool, cotton)
Worn-out dry cell
Electric appliances out of repair, i.e., extension cord, hot pad (for examination)
Mechanical toys illustrating machine principles
Pans of various shapes and sizes
Egg beater
Burned-out light fuses of various kinds
Burned-out light bulbs
Worn-out electric motors (small)
Nut-cracker
Wedges
Thermometer (broken to be examined)
Musical instruments of various kinds
A Pet cage
Projection microscope

IX. Construction Materials.

Those of the regular school kit.

Sources For Materials.

The following companies supply various types of equipment. Most of them do not find it profitable to fill small orders from individual teachers. They suggest that orders for all the schools in the system be pooled, if possible.

1. Acme Educational Laboratory, 119 East 17th Street, New York 3, N. Y. (Distributes a portable laboratory of elementary science equipment.)
2. Cambridge Botanical Supply Co., Waverly, Mass. (General plant supplies.)
3. Carolina Biological Supply Co., Elon College, Elon College, N. C. (Color slides, plaster mounts, biological and chemical supplies.)
4. General Biological Supply House, 761-63 E. 59th Place, Chicago, Ill. (All kinds of biological equipment and supplies.)
5. G. H. Koch, 204 Dexter St., Tonawanda, N. Y. (Distributes a "Science Kit" of carefully selected science equipment.)
6. New York Scientific Supply Co., 111-13 E. 22nd St., New York, N. Y. (General equipment and supplies; also distributes "Stansi" Science Kit.)
7. Southwestern Biological Supply Co., 415 W. Tyler Ave., Dallas, Texas. (General equipment and supplies.)

8. Ward Natural Science Establishment, Inc., 302 N. Goodman St., Rochester, N. Y. (Minerals, fossils and biological supplies.)[1]
9. Models of Industry, Inc., 2804 Tenth St., Berkeley, California. (Model Weather Station Kit. 2 lbs. 6 oz.)

References.

1. Blough, Glenn O. *Materials and Apparatus For Teaching Elementary Science.* Education Brief, No. 1, Revised 1952. Federal Security Agency, Office of Education, Washington, 25, D. C.
2. Wells, Harrington. *Elementary Science Education in American Schools.* McGraw-Hill, Inc., N. Y. 1951.

SELECTED PROFESSIONAL TEXTS, MAGAZINES AND BULLETINS

Texts At the end of *each* section of this bulletin there are pertinent references. In selecting a science library for a school or for an individual, you should refer to each of them.

The following are helpful references to use and to enjoy.

*1. Craig, Gerald S. *Science For the Elementary School Teacher.* Ginn. N. Y. Rev. 1949.

*2. Blough and Huggett. *Methods and Activities in Elementary-School Science.* The Dryden Press. 31 West 54th St. N. Y. 19. 1951.

*3. Blough and Huggett. *Elementary-School Science and How To Teach It.* Dryden Press. N. Y. 1951.

4. National Society For the Study of Education. *Science Education in American Schools.* 46th Yearbook. Univ. of Chicago Press. Chicago. 1947.

5. Wells, Harrington. *Elementary Science Education* in American Public Schools. McGraw-Hill. N. Y. 1951.

6. Shacter and others. *Into Your Teens.* Scott. N. Y. 1949.

7. *Experiment* Reference. Section on "Using Experiments" this bulletin, p. ——

8. *Library For Boys and Girls Reference.* Section "Selected Science Library For Boys and Girls," this bulletin, p.

9. *Audio-Visual* References. Section on "A Suggested List of Audio-Visual Materials."

Selected Magazines

1. National Association of Audubon Societies. *Audubon.* 1000 Fifth Avenue. N. Y. 28. (Deals mainly with bird lore.)

2. American Museum of Natural History. *Junior Natural History.* 79th St. Central Park West. N. Y. (monthly) $1.50.

3. Pruitt, C. M. *Science Education.* National Council on Elementary Science. Quarterly. School of Education, Oklahoma A and M College, Stillwell, Oklahoma.

4. Wildlife Resources Commission. *Wildlife in North Carolina.* Raleigh, N. Carolina. 12 issues 50c.

Selected Bulletins and Pamphlets

1. Zim, Herbert S. *Science For Children and Teachers.* ACEI. 1200-15th St. N.W. Washington 5, D. C. Bulletin No. 91. 1953. 55 p. 75c

2. U. S. Office of Education. *Education Briefs.* No. 21,8,26, 3,12 and others. Department of Health, Education and Welfare, Washington, D. C. 15¢
3. Schneider, Elsa. *how children and teachers Work Together.* ACEI. 1200-15th St. Washington 5, D. C. 15¢
4. National Science Teachers Association *Elementary School Science Bulletins.* NEA. 1201-16th St. N.W. Washington, 6, D. C. (To members.)
5. National Commission on Safety Education. 1. *Safety Through Elementary Science.* 1949. 39 p. 50¢
   2. *Fire Safety for Teachers of Primary Grades.* NEA. 1201-16th St. N. W. Washington 6, D. C. 1950. 50¢
6. N. Y. State College of Agriculture. *Cornell Rural School Leaflets.* Cornell University, Ithaca, N. Y. Quarterly. 3 for children, 1 for the teacher each quarter. One science subject each member. 50¢ (Index to previous numbers Sept. 1941 to Sept. 1952. Vol. 46. No. I Fall 1952. *Pamphlets* on subjects from air to yeast.)
7. National Garden Institute. *"School Gardengram."* 1368 N. High St. Columbus, Ohio. (Current.)
8. Blough and Blackwood. *Science Teaching in Rural and Small Town Schools.* Bulletin No. 5. 20¢ Office of Education. Dept. of Health, Education and Welfare. Washington 25, D. C. 1949. 15¢
9. Blough and Blackwood. *teaching elementary science.* Office of Education. Washington, D. C. Bulletin No. 4. 1948. 15¢
10. General Biological Supply House. *"Turtox News."* 761-63 East 69th Place. Chicago 37, Ill. (Also "Turtox" one page leaflets)
11. Carolina Biological Supply House. *"Carolina Tips."* Elon College, North Carolina.
12. National Audubon Society. *Audubon Nature Bulletin.* 1000 Fifth Avenue, N. Y. 28. N. Y. (10 issues per year).
13. Westinghouse Electric and Manufacturing Co. *The Westinghouse Little Science Series.* School Service. 304 Fourth Ave. Pittsburgh, 30, Penn.
14. Air Age Education Research. *"The Airplane and How It Flies."* 100 Park Ave. New York 17.
15. American Humane Society. *"Care of Dogs."* 180 Longwood Ave., Boston, 15. (Other Pamphlets).
16. Appalachian Hardwood Manufacturers, Inc. *"Appalachian Hardwoods, America's Finest."* 414 Walnut St. Cincinnati, 2, Ohio.

17. American Museum of Natural History. *"Man and Nature."* Central Park West at 79th St. New York, 24. (a catalog of popular scientific publications of the museum).
18. Hayden Planetarium. *"Inexpensive Star Explorers Chart."* 81st at Central Park. New York, N. Y. 50¢
19. American Education Press. *Current Science and Aviation.* 400 South Front St. Columbus, Ohio. (General science and aviation subject matter for children.)
20. Science Service. *Science News Letter.* 1719 N. Street, Washington, D. C. (weekly from September to June, useable).
21. Lewellen, John, *Exploring Atomic Energy.* Science Research Association. 57 West Grand Ave. Chicago, Ill. 1951. 40¢

Important Points in Selecting and Assembling Material.

In addition to the titles given here a number of Federal and State agencies have some available materials to a very limited extent. There are, however, several *cautions* we need to recognize regarding them:

1. Only one letter should be sent from a school; the letter should be exact in inquiry and "exactly written." Ask for *only* one bulletin of a kind. The teacher or the principal should make the request. (*The Tar Heel State* is available in larger quantities.)
2. The pamphlets and bulletins issued by the State Departments *cannot* be secured for individual children in a class.
3. The booklets and pamphlets from any source should *not be used for scrapbooks* for either an individual or a school project.
4. Booklets and pamphlets are often valuable and expensive. They should be indexed in the central library for the elementary school and serve as a pertinent reference.

Example A. *The Neuse* by Ben Dixon McNeill, issued by the State Committee on Water Resoruces of the State Department of Conservation and Development, 1952, is an example of a State pamphlet *to learn from, enjoy and share with others* by preserving it as it is used.

Example B. When a pamphlet is for sale, as *Common Forest Trees of North Carolina,* N. C. Department of Conservation and Development, 10¢

each, the school does not need one for every child. Emphasis should be given to conservation in grade four and particularly in grade eight.

Example C. The bulletin, *North Carolina's Natural Resources,* State Department of Conservation and Development, 1952, was sent, on request, or is available, one copy for *each* eighth grade section.

The Department of Conservation and Development plans to sample each school with the bulletins that are issued that would be available.

Example D. The bulletin, *Geology and Mineral Resources of North Carolina,* by Stuckey and Steel, Department of Conservation and Development, Raleigh, 1953, has been sent to the libraries of the public schools. A valuable contribution, particularly in the eighth grade program.

Reading professional literature can be an enjoyable way for the teacher to think and "talk" with authors. Reading books of science should be the heritage of the child.

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